Project
Quantum
Leap

SAMPLER

http:// www.lagcc.cuny.edu/ctl/pql/sampler

Contextualizing the study of Basic Skills Mathematics
at LaGuardia Community College

LaGuardia Center for Teaching and Learning

LaGuardia Community College
City University of New York

CUNY The City University of New York

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Cover Images (clockwise from upper left)

Loesslein, R. (Developer). [Untitled graph of weather data in Augsberg, Germany]. Retrieved February 16, 2009 from: http://synoptic.weaintplastic.com

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middle college national consortium
DRIVING EDUCATIONAL INNOVATION

version 3

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Table of Contents

Project Quantum Leap

Foreword

Paul Arcario
Dean for Academic Affairs

Project Quantum Leap

Project Quantum Leap is part of a nationwide effort to solve the challenge of basic skills education in math. A U.S. Department of Education study[1] reiterates the importance of math instruction for college success: students who take college-level math as early as possible (no matter their eventual major) are far more likely to attain a degree. At community colleges, however, most entering students are not ready for college-level math. Developmental or basic skills classes account for over half (55%) of math enrollments.[2] Many of the students who take these courses never progress; dropout and failure rates in basic skills courses are high, as is student dissatisfaction.[3] Clearly, new instructional strategies are needed.

Project Quantum Leap is an innovative effort by the Department of Mathematics, Engineering, and Computer Science of LaGuardia Community College to address the challenges of basic skills education in math. With funding from the U.S Department of Education's Fund for the Improvement of Postsecondary Education (FIPSE) and assistance from the LaGuardia Center for Teaching and Learning, math faculty have made a sustained, collective effort to explore new approaches to teaching math and re-thinking their classroom pedagogies. Working together in a faculty seminar, they design, plan, test, and discuss new classroom strategies. The PQL faculty are proud to publish the first edition of the *PQL Sampler,* a representation of, and reflection on, their initial classroom experiments. With this publication, we celebrate the accomplishment of a team of thoughtful, risk-taking teachers and a department dedicated to innovation and creativity.

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1 Adelman, C. (2006). *The Toolbox Revisited: Paths to Degree Completion from High School through College.* U.S. Department of Education.

2 Conference Board for the Mathematical Sciences (CBMS). (2002). *Statistical Abstract of Undergraduate Programs in the Mathematical Sciences in the United States* .

3 Grubb, N.W., & Cox, R. (2005). Pedagogical Alignment and Curricular Consistency: The Challenges from Developmental Education. *Directions in Community Colleges: Responding to the Challenges of Developmental Education,* 129, 93–103.

Introduction

Bret Eynon, Assistant Dean for Academic Affairs
Judit Török, Center for Teaching and Learning

In an effort to improve student learning outcomes in developmental math, LaGuardia faculty have studied a successful math and science teaching approach developed by a national project funded by the National Science Foundation. This award-winning project, Science Education for New Civic Engagements and Responsibilities (SENCER), has demonstrated the effectiveness of teaching math in compelling contexts. Linking the study of math to complex, capacious, and unsolved public issues, SENCER courses make math more meaningful and engaging for students.

Project Quantum Leap (PQL) adapts the SENCER approach to meet the needs of a new setting and population: community college students taking developmental math. Studying the SENCER approach and drawing on their own knowledge, LaGuardia's math faculty have developed problems and projects that integrate contextual themes in four math courses:

Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Elementary Algebra – Problems and Issues in Public Health (MAT096)

College Algebra – Trigonometry - Business and Finance (MAT115)

Elementary Statistics I – Energy and the Environment: Global Challenge (MAT120)

For the past two years, LaGuardia faculty have worked together to design lessons and courses that use math to solve problems in these areas, and to test them with LaGuardia students. The *PQL Sampler* is the first fruit of that effort.

The *PQL Sampler*

The *PQL Sampler* is a collection of math projects and assignments developed by LaGuardia faculty while participating in the PQL Seminar. These lessons take root in the SENCER approach by focusing on engaging and relevant public issues while keeping rigorous mathematical practices as their main objective. The lessons are presented here as a resource for other faculty and a prompt for further innovation.

The *Sampler* includes a range of lessons on each contextual theme. Under the theme of the environment, for example, lessons focus on understanding environmental pollution, protecting our natural resources, and making wiser choices in our everyday lives. Lesson topics include:

- requiring students to calculate CO_2 emissions
- using math to decide whether paper diapers or cloth diapers are more environmentally friendly
- determining how much electricity we can save by using certain types of household appliances

In the second thematic area, students analyze graphs and numerical data about issues of public and personal health. These lessons engage students with questions about the causes and severity of disease, as well as ways to practice making healthier choices about food and lifestyles. For example, the *Sampler* includes lessons that:

- have students explore the issues of asthma and obesity
- help students understand the health effects of toxic materials in our environment
- ask students to calculate the number of deaths related to AIDS and other epidemics

In the third thematic area, students create graphs and practice exponential modeling as they grapple with topics of interest related to the economy and personal finance. Lesson topics include:

- investigating the causes and effects of rising gas prices
- understanding investment and calculating investment rates
- learning how math can help when buying a new house

Some PQL math courses were taught in learning communities, paired with Critical Thinking. In these paired courses, math and humanities faculty worked together, designing courses that encouraged students to understand the connections between the different disciplines. The *PQL Sampler* includes lesson plans that emphasize the pedagogy of integrative learning and highlight the effectiveness of interdisciplinary teaching.

The *PQL Sampler* is an exciting achievement by a group of thoughtful and dedicated faculty. It can also serve as a resource for other faculty, at LaGuardia and other colleges, interested in using the PQL approach in their courses. The *Sampler* is organized according to math levels. Each lesson indicates what mathematical concepts are covered in the assignment and when to introduce it during the semester. Some lessons might introduce a particular topic, while others might synthesize or review previously taught materials. Attached to all the lessons are student handouts and reading materials that allow others to adopt or customize these lessons to their course goals and needs.

While it is a significant accomplishment, the *Sampler* is far from complete. It will grow and expand as LaGuardia faculty create new teaching materials and classroom projects. We will update and improve this resource as the project grows, in the hope that it will serve as a springboard for sustained faculty learning and classroom innovation.

Acknowledgments

This Project Quantum Leap *Sampler* would not be possible without a broad effort involving many different individuals and organizations. The LaGuardia Center for Teaching and Learning is pleased to express appreciation to those who made possible the rich variety of teaching and learning displayed here.

Primary funding for Project Quantum Leap (PQL) was provided to LaGuardia by the Fund for the Improvement of Post-Secondary Education (FIPSE) of the U.S. Department of Education in response to a grant proposal written by Dean Paul Arcario. We are pleased to have an opportunity to thank the Department and the FIPSE program for their generous support. Supplemental funding for an Early College extension of the 2008 program was provided by the Middle College National Consortium, drawing on funds originally provided by the Bill and Melinda Gates Foundation. Sustaining funds for PQL activities have been provided by the Title V program of the U.S. Department of Education. We wish to thank all those who have helped us by supporting this classroom-focused faculty and curriculum development activity.

The original plan for Project Quantum Leap emerged from an examination of a project funded by the National Science Foundation, entitled Science Education for New Civic Engagements and Responsibilities (SENCER). The leadership of SENCER, especially Professor David Ferguson, has been generous in providing advice and support for our effort.

President Gail Mellow, Vice President Peter Katopes and the college community have supported PQL every step of the way. Their faith and interest in PQL helps to ensure its success. We deeply thank Dean Paul Arcario and Dr. Kamal Hajallie, Chair of the Department of Mathematics, Engineering, and Computer Science (MECS) for their vision of contextualized basic skills instruction in mathematics. Their wise leadership is irreplaceable.

We thank our PQL mathematics faculty leaders, Professors Prabha Betne, Gordon Crandall, and Frank Wang, for their countless contributions to the project and their sustained work on the *Sampler*. Professors Unn Hidle, Milton Hollar-Gregory, and Robyn O'Kane serve as contextual consultants. Dr. Judit Török coordinates PQL with assistance from the faculty team and Assistant Dean and LaGuardia Center for Teaching and Learning Director, Dr. Bret Eynon. Her skill and commitment has been crucial to the program since its inception.

Publication takes a team. Our faculty and staff leadership team took on the initial task of soliciting faculty contributions and was instrumental in editing key sections. Center for Teaching and Learning staff members Craig Kasprzak, Roslyn Orgel, and Priscilla Stadler were tireless in the editing, proofreading and production process. Stadler also designed the PQL website, with help from Center staff Miki Masuda, Prasha Tuladhar and Louis Shrestha. Ethan Ries, of grafilicious inc., developed our print design and assisted with the final production.

We are especially grateful to all faculty who contributed their lessons and reflections to the *PQL Sampler*. This publication—and indeed the broader PQL project – are absolutely dependent upon faculty interest in innovation, commitment to students, and collegiality in sharing the lessons they've developed. We thank faculty for their effort, their collaborative spirit, and their willingness to try out new approaches. And we hope that this *Sampler* is a valuable tool for educators seeking to enrich their classrooms, expand the breadth of math pedagogy, and advance the success of all our students.

Activities

Project Quantum Leap

SECTION 1: INTRODUCTION TO ALGEBRA
Energy and the Environment: Global Challenge (MAT095)

SECTION 2: ELEMENTARY ALGEBRA
Problems and Issues in Public Health (MAT096)

1

INTRODUCTION TO ALGEBRA

Energy and the Environment: Global Challenge (MAT095)

Project Quantum Leap

This course has a problem-solving approach that emphasizes the importance of mathematical reasoning in addressing real-world problems drawn from diverse disciplines. Topics include arithmetic (signed numbers, fractions, decimals and percentages), elementary algebra (solving first-degree equations and inequalities, rules of exponents, equations of lines) and basics of geometry (area and perimeter) as well as numeracy (estimation, unit analysis). The course is intended for students with little or no algebra background.

CO_2 Emissions by Cars

Sreedevi Ande
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

Students will use their mathematical skills to gain an understanding of the numerical facts about carbon dioxide (CO_2) emissions by a variety of models of cars. After students read an assigned handout, they will be asked to perform basic math computations involving ratios, measurements, and plotting graphs.

Math Topics
Measurements, plotting graphs, and ratios

Purpose
Synthesis

Comments
Exercises are based on reading the handout

When to Introduce
Week 10 (after introducing measurements and plotting graphs)

Activity Time Frame
One hour: a half -hour lesson in class and a half -hour discussion of answers

Reflection

In the first part of the activity, students will be given reading material consisting of actual numerical data on carbon dioxide emissions for different models of cars and transportation choices by country. This activity has a problem-solving approach that emphasizes the importance of mathematical reasoning in understanding the impact of various passenger cars on air pollution. Students will be asked to answer the questions that involve measurements, plotting graphs, and ratios. In the second part, students will be asked to read an online article and write a reflection on their understanding.

Presenting real data motivates students and leads to good class discussion. This information will help students realize the effects of transportation on the environment and motivate them to play an effective role in minimizing CO_2 emissions, by considering “greener” modes of transportation such as public transportation, bicycles, share-a-ride, etc. Most importantly, students will see how math plays a vital role in understanding environmental issues. The COMPASS-type word problems that were created from the reading material will help students to see the connection between math and its role in understanding real-life issues.

Activity Overview

Reading

This activity is recommended for the tenth week of the semester. The first part involves reading some facts related to CO_2 emissions from transportation, followed by data on CO_2 emissions by car and transportation choices by country. The reading material is compiled from different reliable sources. The website links of the sources are provided in the Materials and Resources section. In the second part of the activity, students should be directed to the website: http://www.ucsusa.org/clean_vehicles/vehicles_health/automaker-rankings-2007.html where they download and read the two-page article entitled “Automaker Rankings 2007 Brochure.”

Assignment
The first reading activity is followed by a set of eight comprehension questions. The questions require students to read the material thoroughly, capture the numerical facts presented in the reading, and be able to use them to answer the questions. The second part of the activity requires that students answer questions which are completely based on reading the Automaker Rankings 2007 article. The questions from both activities will be assigned as homework and will be graded. All answers will be discussed in class.

Class Discussion and Math Exercise Problems
The reading will develop the required background that students need to participate in class discussions and answer the math exercise problems. The exercises are word problems based on the reading, which involve ratios, measurements, and plotting graphs. This activity will also help students to understand that transportation is the largest single source of air pollution in the United States.

Reflection
Students are expected to write a reflection on their understanding of carbon dioxide emissions, the Automaker Rankings 2007 brochure, and the impact of emissions on the environment. Based on their reading, problem-solving and discussion, students will make recommendations for improving environmental performance. Their reflection will be evaluated by the instructor.

Materials and Resources

- Handout

The following websites provide information on air pollution:

- Bluejay, M. (n.d.). Transportation almanac: Stastistics about cars, energy, pollution, bikes, and more. *Bicycle Information Info*. Retrieved February 3, 2009, from http://bicycleuniverse.info/transpo/almanac.html

- Terrapass. (2009). *Carbon footprint calculator*. Retrieved February 3, 2009, from http://www.terrapass.com/

- Union of Concerned Scientists. (2009). Automaker rankings 2007. In *Clean Vehicles*. Retrieved February 3, 2009, from http://www.ucsusa.org/clean_vehicles/vehicles_health/automaker-rankings-2007.html

- Union of Concerned Scientists. (2009). Cars, trucks, & air pollution. In *Clean Vehicles*. Retrieved February 3, 2009, from http://www.ucsusa.org/clean_vehicles/vehicle_impacts/cars_pickups_and_suvs/cars-trucks-air-pollution.html

Handout: CO_2 Emissions by Cars

Ande | Introduction to Algebra –The Environment (MAT095)

Part I

> *Transportation is the largest single source of air pollution in the United States. It produces over half of the carbon monoxide, over a third of the nitrogen oxides, and almost a quarter of the hydrocarbons in our atmosphere. . . . With the number of vehicles on the road and the number of vehicle-miles traveled escalating rapidly, we are on the fast lane to smoggy skies and dirty air.*
>
> – Cars, Trucks, & Air Pollution, 2009

The major pollutants from motor vehicles are particulate matter (PM), hydrocarbons (HC), nitrogen oxides (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), hazardous air pollutants (toxics), and greenhouse gases (such as carbon dioxide).

The Table below shows the carbon dioxide (CO_2) emissions by different 2008 model cars with a mileage of 10,000 miles/year

Table 1 – Carbon dioxide (CO_2) emissions by different 2008 model cars with a mileage of 10,000 miles/year.

Car Make	Model	Carbon Dioxide Emission (lbs/year)
Acura	TL	9,316
Audi	A3	7,826
BMW	328CI	8,506
Buick	Enclave AWD	10,297
Cadillac	CTS	9,316
Ford	Edge AWD	10,869
Honda	Civic	6,521
Mercedes-Benz	C350	9,316
Nissan	Altima	8,152
Toyota	Corolla	6,521

Source: Terrapass, 2009

Answer the following questions based on the information given in Table 1.

1. Draw a graph showing carbon dioxide emissions per vehicle.
2. Calculate carbon dioxide emitted in lbs/day by Ford Edge AWD.
3. Calculate carbon dioxide emitted in lbs/day by Nissan Altima.
4. Calculate carbon dioxide emitted in kg/year by Toyota Corolla.
5. Calculate carbon dioxide emitted in kg/year by Audi A3.

Table 2 – Popularity of transportation choices by country

Trips made by …	US	Canada	Netherlands
Car	89%	76%	45%
Public Transit	2%	10%	7%
Walking	6%	10%	18%
Bicycle	1%	2%	28%
Other	3%	2%	2%

Source: Bluejay

6. What is your understanding of carbon dioxide emissions and the impact of emissions on the environment? Do the current levels of carbon dioxide emissions raise a concern about the current environment? Make recommendations for minimizing emissions.

Answer the following questions based on the information given in Table 2.

1. What is the ratio of public transit use to car use in the U.S.?
2. What is the ratio of walking to bicycle riding in the Netherlands?
3. Which country do you think is generating the most greenhouse gases, and why?

Part II

Download and read the article "Automaker Rankings 2007 Brochure" from the Union of Concerned Scientists Clean Vehicles website: http://www.ucsusa.org/clean_vehicles/vehicles_health/automaker-rankings-2007.html.

Answer the following questions based on the reading.

1. Which automakers consistently have better-than-average performance in both the smog and global warming categories in every vehicle class?
2. Which automaker has the best model in its class in one or more environmental categories?
3. What should be your preference regarding emissions and fuel economy when you purchase a car or truck the next time?
4. Which automaker earned the Greenest Automaker Award in the Union of Concerned Scientists' comprehensive ranking for the fourth consecutive time?
5. Which automaker manufacturer has the highest fleet average environmental score and which one has the lowest score? What do these scores indicate regarding pollution?
6. Which automaker is the top peddler of vehicles rated at 15 mpg or worse in city driving?
7. Why is DaimlerChrysler Public Polluter #1?

References

- Bluejay, M. (n.d.) Transportation almanac: Stastistics about cars, energy, pollution, bikes, and more. *Bicycle Information Info*. Retrieved February 3, 2009, from http://bicycleuniverse.info/transpo/almanac.html
- Terrapass. (2009). *Carbon footprint calculator*. Retrieved February 3, 2009, from http://www.terrapass.com/
- Union of Concerned Scientists. (2009). Automaker rankings 2007. In *Clean Vehicles*. Retrieved February 3, 2009, from http://www.ucsusa.org/clean_vehicles/vehicles_health/automaker-rankings-2007.html
- Union of Concerned Scientists. (2009). Cars, trucks, & air pollution. In *Clean Vehicles*. Retrieved February 3, 2009, from http://www.ucsusa.org/clean_vehicles/vehicle_impacts/cars_pickups_and_suvs/cars-trucks-air-pollution.html

Carbon Emission

Prabha Betne
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

Students will study graphs about carbon emission in different regions of the world and perform calculations. Students should understand how the numbers indicated in the graphs were obtained. During this process students will learn the concept of weighted average.

Math Topics
Reading graphs, weighted average, unit conversion, decimals

Purpose
Motivation

Comments
Exercises are based on reading graphs and real-life data derived from the graphs

When to Introduce
Week 6 (or when weighted average is introduced)

Activity Time Frame
One week; one hour-long lesson in class and two hours to finish homework

Reflection

Increased levels of carbon in the atmosphere are a significant factor that greatly contributes to global warming. One might think that less developed regions of the world contribute more pollution and hence also have higher levels of carbon emission than more developed regions of the world, but many studies have found the opposite.

This activity is based on two graphs and a brief text from pages 252 and 253 of the book *An Inconvenient Truth* by Al Gore. I showed the graphs in class using a multimedia projector (using photocopies of the two pages as handouts would be preferable because students can take a closer look at the graphs). Then we studied the two graphs about carbon emission per person for seven different regions of the world. Students were surprised to find that developed regions, such as the United States, have higher carbon emissions per person, as well as total carbon, compared to less developed regions, such as India and China (even though these two countries have much larger populations than the U.S.).

The first graph also shows the world average carbon emission to be approximately one ton per person. Here the 'world' is considered to be the seven regions together. I listed the values of carbon emission per person for the seven regions in a table in the student handout. The values were obtained from the graph. Students then calculated the simple average of the carbon emission per person for the seven regions and compared their results with the world average. Since the two values do not match, we had a very good discussion about the reasons for this mismatch based on the following question: What factors should be considered to obtain the world average using the given values for the seven regions? This discussion led to further discussion about weighted average. Students quickly found out that they needed to use population of the regions as weights to find the world average carbon emission by using the given data on carbon emission per person for the seven regions.

I discussed the formulas for finding simple average and weighted average, as well as the similarity between the two. After this discussion, I asked students why the simple average did not work in this situation. (The answer is that in order to find the average carbon emission, we need to obtain the total carbon emission first. The simple sum of carbon emission per person does not obtain the total carbon emission that we need in the numerator. The sum found after multiplying the carbon emission per person value by weights [population] obtains the total carbon emission for the seven regions).

For their homework, students had to discuss the effects of higher levels of carbon in the atmosphere, and speculate about ways to reduce their contribution. They also had to find out their 'carbon footprint,' using a given web link. In addition, there were some skill practice exercises to strengthen their basic math skills.

The activity was a successful introduction to the concept of weighted average. Real-life examples effectively engage students in class discussions and learning. Students were surprised to find out that the U.S. has the highest carbon emission per person and also the highest total carbon emission in the world. We had a lively discussion in the class about why this is the case. Some students were inclined to change their own behavior and lifestyle in order to reduce their contribution.

After this lesson, I assigned a few other application problems related to weighted average to be completed in class. Most students were able to solve the problems correctly. To reinforce the learning, all the questions in the lesson that were discussed in class were also assigned as homework. Although many students performed the calculations properly, they were not able to explain the concepts in words. It was surprising that, even though the first six problems were discussed in class, some students made mistakes in their calculations and thought that simple average would work in this situation.

Activity Overview

Reading

Distribute the handout (copies of pages 252 and 253 of the book *An Inconvenient Truth*, by Al Gore). In class, begin by studying the first graph on page 253. (Chapter 24 of the film, *An Inconvenient Truth,* examines carbon emission and can be shown in class.) Students are required to read the graph and write down the data shown in the graph. The first graph shows carbon emission per person (in tons) for different regions of the world.

A second graph shows carbon emission (in tons) in comparison to the U.S., adjusted by population of each region. This graph and the text on page 252 are required for the homework portion of the lesson. These materials should be discussed in class after discussing weighted average using problems 1–6 in the student handout.

This reading portion can also be assigned as homework to be followed by a class discussion to introduce weighted average.

Class Discussion and Math Exercise Problems

Students answer the questions (1–6) given in the student handout. The question-answer method is useful to understand weighted average. The data on the handout helps students perform the calculations needed for computing the weighted average (average carbon emission per person in the world).

Assignment
All the exercises that are discussed in class and the additional exercises listed at the end of the handout are assigned as homework. Students can type their responses and upload this work in the ePortfolio.

Exercises 7–9 are designed to help students reflect on their understanding of weighted average and the effects of higher levels of carbon in the atmosphere.

Materials and Resources

- Handout
- Paramount Classics. (2006). Calculate your impact. *Official An Inconvenient Truth Global Warming Documentary Movie Site*. Retrieved February 4, 2009, from http://www.climatecrisis.net/takeaction/carboncalculator/
- Gore, A. (2006). *An Inconvenient Truth*. New York: Rodale Books.
- Guggenheim, D. (Director). (2006). *An Inconvenient Truth*. Paramount Home Entertainment. Chapter 24 of the movie a discussion about carbon emission and graphs illustrating carbon emission per person in different regions of the world (for year 1999).
- Population by region is obtained from the UN Department of Economic and Social Affairs Population Division Homepage *World population prospects: The 2006 population revision database*. (2007). Retrieved February 4, 2009, from http://esa.un.org/unpp/
  Any other reliable resources can also be used to obtain the population (in 1999) by region.

Handout: Weighted Average

Betne | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Consider the first graph given on the top of page 253 of Al Gore's book, *An Inconvenient Truth*. It is a bar graph that shows carbon emissions per person (in tons) in seven different regions of the world including the U.S. Also note that the world average carbon emission per person (approximately 1 ton) is shown on the graph using a line. (Here, the world average means the average for the seven regions) The following data is obtained from this graph. (Please note that these are approximate values.)

Region	Carbon/person per year in 1999 (in tons)
Africa	0.15
India	0.20
China	0.45
Japan	2.30
EU	2.30
Russia	2.80
U.S.	5.60

1. Which region/country has the highest carbon emission per person and which country has the lowest? The highest value of carbon emission per person is how many times the lowest value? What are some reasons for higher values of carbon emission?
2. What information (or data) do you need in order to find carbon emissions per person for each region? Then explain what calculations you will perform to obtain the carbon emissions per person for a region. (Hint: for example, think about what data you need, and what calculations you will perform to obtain the value 0.15 tons carbon per person for Africa.)
3. Find the simple average of the carbon per person (the numbers given in the second column of the above table) by adding them and dividing by 7. Compare this average with the world average (approximately 1 ton per person) given in the same graph on page 253 from Al Gore's *An Inconvenient Truth*. Do the values match? Why?
4. Should we compute simple average or weighted average to obtain the average carbon emissions per person for these seven regions together? Why?
5. What factor you will consider for weights in order to obtain the weighted average of carbon emission per person for the seven regions?
6. The population of the seven regions is given in the table below. Use population as weights

and find the weighted average of carbon per person. Compare your weighted average with the world average (approximately 1 ton per person) given in the graph.

Homework

Region	Population (in year 2000)	Carbon/person (in tons)
Africa	820,959,000	0.15
India	1,046,235,000	0.20
China	1,269,962,000	0.45
Japan	127,034,000	2.30
EU	486,642,000	2.30
Russia	143,953,000	2.80
U.S.	284,857,000	5.60

Source: UN Department of Economic and Social Affairs Population Division Homepage. (2007). ***World Population Prospects: The 2006 Population Revision Database***. Retrieved February 4, 2009, from http://esa.un.org/unpp/

1. Explain in a few sentences when one should use simple average and when one should use weighted average.
2. Calculate your carbon footprint using the *An Inconvenient Truth* website: http://www.climatecrisis.net/takeaction/carboncalculator/. The national average is 7.5 tons per year. Your value is how much lower or higher compared to the national average?
3. What effects do higher levels of carbon emission have on the environment? What can you do to reduce your contribution of carbon to the earth's atmosphere?

Additional exercises

1. Convert the units of carbon emission from tons to pounds (1 ton = 2000 pounds).
2. Round off the population numbers to nearest millions.
3. Read the text given on the top of page 252 of *An Inconvenient Truth*. Explain how to obtain the carbon emission per region (after population size is adjusted in comparison to U.S.) shown in the second graph at the bottom of the page 253. Perform the computations to obtain the carbon emission per region and compare them with the carbon emission per region indicated by the graph. Write down your findings.

Trends in CO_2 and Global Temperature

Prabha Betne
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

In this activity students will apply their math skills to real data in order to understand the relationship between global temperature and carbon dioxide concentration in the earth's atmosphere. After reading an assigned report, which includes graphs, students will be asked to estimate numbers from the graph, draw the graph, recognize patterns in the graph, and write an equation to express the patterns. Through this activity, students will learn the concepts of linear equation, slope and intercept, and prediction using equations.

Math Topics
Graphs, linear equations and slope, solving two-step equations

Purpose
Motivation

Comments
Exercises are based on reading and real-life data derived from graphs

When to Introduce
Week 9 (or when linear equations and slope concepts are introduced)

Activity Time Frame
Three days: assign reading on the first day, discuss for one hour in class on the next, collect writing assignment on the final day

Reflection

The environment was used as a general theme throughout the course to contextualize math topics. Early in the course, students read about global warming and its causes. It is interesting to know that, although global warming seems like a recent phenomenon, the earth's climate has changed consistently throughout its history. Some known causes of climate change include changes in the earth's orbit, volcanic eruptions, changes in ocean currents, changes in greenhouse gas concentrations, etc.

The purpose of the reading assignment in this activity is to educate students about past climate changes. By studying a graph depicting the recent phenomenon of increasing levels of carbon dioxide and global temperature, students will realize the importance of collecting and studying data in making predictions and scientific discovery.

Other than the reading, most of this activity was conducted in class. The math problems are designed to teach students the concepts of linear equation, slope, intercept, interpretations of slope and intercept in real life situations, and relationships between two quantities. The exercises involved estimating data points (global average temperature and carbon dioxide concentration) from the graph, drawing a graph using the obtained data, recognizing patterns in the graph (which is approximately a straight line), calculating the slope of the line from the given data, and comparing the results with the facts provided in the reading. Students were asked to formulate an equation for a straight line using the given data, and to predict the CO_2 concentration for 2010 using the equation. Students also explored the concept of two related variables by graphing the global temperatures versus the carbon dioxide concentration amounts over the years. As a homework assignment, students were asked to re-do the exercise problems, then write about their findings and discuss whether their findings suggest the possibility of climate change. Through this exercise, I hoped that students would learn to read critically and be able to interpret their findings in real life.

When I discussed the activity in class, students were really motivated and engaged by the exploratory nature of the activity. They seemed to understand the concepts involved in a straight line equation. They were intrigued by their findings of slope values that were very close to the "rate of increase" value that is mentioned in the reading (CO_2 increases at a rate of approximately 1.6ppm per year). Although the activity caught the students' attention, they required hints and clues to solve the problems and interpret the results.

To follow the syllabus, this activity was assigned and discussed towards the very end of the semester. As a result, few students seemed to have completed the assigned reading and fewer submitted the homework assigned after the class discussion. Among those who submitted, only a few attempted to write about their findings. So, it was difficult to judge the impact of this activity in terms of students' retention of their learning and ability to interpret the results. However, the activity was very successful in introducing the topics of graphing, linear equations and slope.

To make this activity more successful, I would add homework questions based on reading comprehension to make sure that students complete the assigned reading. Exercises based on estimating data and graphing can also be added to the homework questions. With some time management in class, a brief writing activity could be conducted and the homework assignment could be to revise the in-class writing.

Activity Overview

Reading

Assign the reading material (three pages) as homework at least a day before the in-class discussion.

The in-class activity is based on two readings that contain about two pages of text and two graphs. The reading is about incidences of past climate changes and their relation to the levels of average global temperature and CO_2 concentration. The graphs show the relation between global temperature and CO_2 levels. (See the attached reading assignment handout.)

Class Discussion and Math Exercise Problems

The attached handout for in-class discussion required students to:

- Graph the CO_2 concentration data versus the years (problem # 1). The data can either be provided, or students can estimate the data from the graph in Figure 2 and fill in the table first before drawing the graph. Students are asked to recognize the pattern (straight line) in the graph. At this point, straight line equations should be introduced and the formula for slope should be discussed. Use an example of a straight line equation such as: $Y = 2 + 3x$ to create a table of x and y values, draw the graph to show that the graph is a straight line, and compute slope using two points on the graph to show that it matches the coefficient of x in the equation.

- Compute the slopes (problem # 2) at three different points using a formula. The meaning and interpretation of the slope of a straight line was discussed in class. The text in the beginning of the handout mentions that CO_2 increases at a rate of approximately 1.6ppm per year. Students are asked either to justify or contradict this claim. The three slopes that the students find and the average of the three slopes were close to 1.6, which justified the claim.

- Write an equation of a straight line (problem # 3) and make a prediction.

- Practice basic skills by converting CO_2 values to fractions to decimals to percentages (problem # 4).
- Draw a graph of temperature versus CO_2 (problem # 5) and discuss whether the two quantities are related. (Students could also discuss positive or negative relation, as in the study of correlation.) Ask what pattern is observed in the graph.

Homework and Reflection

The entire set of exercises was assigned as homework in addition to problems # 6 and #7. The last problem (#7) was a reflection question. It required students to reflect on their understanding of climate change and its relation to temperature and CO_2 concentration level.

Materials and Resources

- Handout
- Reading #1: United States Environmental Protection Agency. (2008, March 24). *Past climate change*. Retrieved February 4, 2009, from http://www.epa.gov/climatechange/science/pastcc.html
- Reading #2: Woods Hole Research Center. (2008). *Scientific evidence: increasing temperatures & greenhouse gases*. Retrieved February 4, 2009, from http://www.whrc.org/resources/online_publications/warming_earth/scientific_evidence.htm

Additional reading materials about past climate change:

- Carbon Dioxide Information Analysis Center. (1994, September). *Historical CO_2 record from the Siple Station ice core*. Retrieved February 4, 2009, from http://cdiac.ornl.gov/ftp/trends/co2/siple2.013
- National Climatic Data Center. (2008, February 7). *Global surface temperature anomalies*. Retrieved February 4, 2009, from http://www.ncdc.noaa.gov/oa/ncdc.html
- NOAA Earth Systems Research Laboratory Global Monitoring Division. (n.d.). A*tmospheric carbon dioxide - Mauna Loa*. Retrieved February 13, 2009, from http://www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mlo.html

Handout

Betne | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Source: Woods Hole Research Center. (2008). *Scientific evidence: increasing temperatures & greenhouse gases*. Retrieved February 4, 2009, from http://www.whrc.org/resources/online_publications/warming_earth/scientific_evidence.htm

Class Discussion

> *Other evidence of the reality of global warming continues to accumulate. Consistent with predictions of the IPCC [Intergovernmental Panel on Climate Change] since 1990, global average temperatures have indeed been rising while atmospheric CO_2 increases at a rate of approximately 1.6ppm per year.*
>
> – Woods Hole, 2008

1. Draw a graph of CO_2 concentration versus year. What is the shape of the graph?

Average global temperature and CO_2 concentrations between 1960 and 2005

Year	Global Average Temp (°F)	CO_2 concentration in parts per million (ppm)
1960	57.2	315
1965	57.1	320
1970	56.9	324
1975	57.0	334
1980	57.3	340
1985	57.2	348
1990	57.7	354
1995	57.7	361
2000	57.7	370
2005	58.0	375

2. Use the above data to estimate the rate of change in CO_2 concentration between 1980 and 1985, between 1990 and 1995, and between 2000 and 2005. Does your result support the fact stated above the table (i.e. that atmospheric CO_2 increases at a rate of approximately 1.6ppm)?

3. Challenge: Use the fact that the atmospheric CO_2 (Y) increases at a rate of approximately 1.6ppm to write the equation of a straight line using the CO_2 concentration in 1960 as the base value and the number of years since 1960 as X. Then use the equation to predict the CO_2 concentration for 2010.

4. Write the values of CO_2 concentration as a fraction, decimal and percentage.

5. Draw a graph of CO_2 concentration versus temperature values. What pattern do you

observe? What can you conclude from this graph about the relation between CO_2 concentration and global temperature?

Homework

Re-do all the above problems that were discussed in class, then answer the following two questions.

1. Explain why the equation $Y = mX + b$ is a straight line equation. What are m and b in this equation? How do we interpret the values of m and b? Explain using an example. (You may use the example that was discussed in class.)
2. Reflection: From the temperature and CO_2 graph given in Figure 1 in the reading assignment, compare past levels of CO_2 and average global temperature with current levels and explain what you observe. What were some of the effects of the rise and fall of temperature and CO_2 amounts? Do the current levels of CO_2 and temperature raise any concern about the current climate and environment? Explain.

Source

Woods Hole Research Center. (2008). *Scientific evidence: increasing temperatures & greenhouse gases*. Retrieved February 4, 2009, from http://www.whrc.org/resources/online_publications/warming_earth/scientific_evidence.htm

Reading #1: Past Climate Change

Betne | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Source: United States Environmental Protection Agency. (2008, March 24). *Climate change*. Retrieved February 4, 2009, from http://www.epa.gov/climatechange

Past Climate Change

The Earth's climate has changed throughout history. From glacial periods (or "ice ages") when ice covered significant portions of the Earth to interglacial periods when ice retreated to the poles or melted entirely, the climate has continuously changed.

Causes of Change

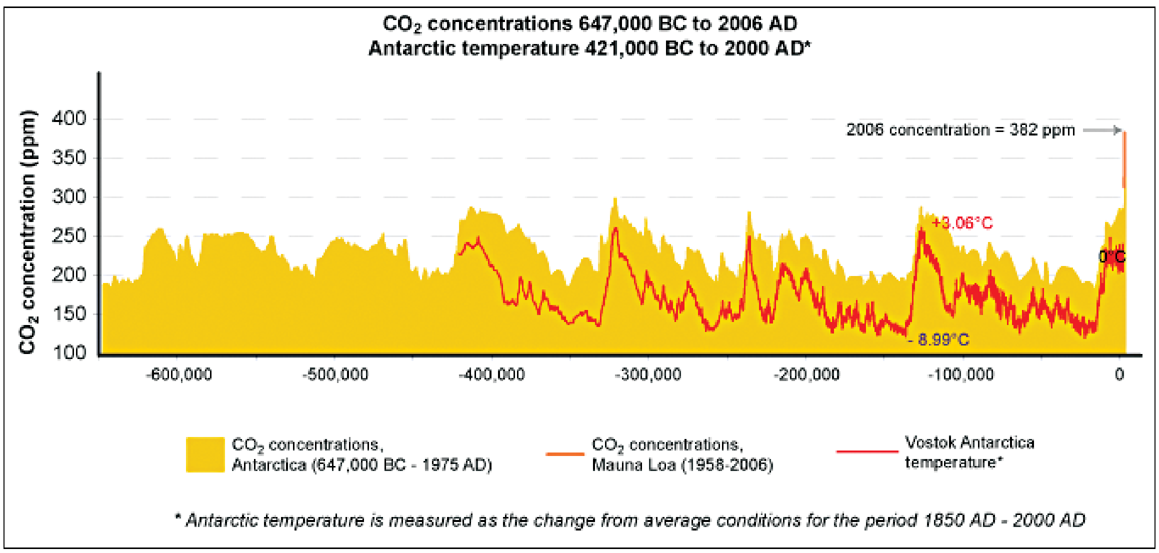
Known causes or "drivers" of past climate change include:

- *Changes in the Earth's orbit:* Changes in the shape of the Earth's orbit (or eccentricity) as well as the Earth's tilt and precession affect the amount of sunlight received on the Earth's surface. These orbital processes are thought to be the most significant drivers of ice ages according to the theory of Mulitin Milankovitch, a Serbian mathematician (1879–1958).
- *Changes in the sun's intensity:* Changes occurring within (or inside) the sun can affect the intensity of the sunlight that reaches the Earth's surface. The intensity of the sunlight can cause either warming (from stronger solar intensity) or cooling (from weaker solar intensity). According to NASA research, reduced solar activity from the 1400s to the 1700s was likely a key factor in the "Little Ice Age," which resulted in a slight cooling of North America, Europe and probably other areas around the globe.
- *Volcanic eruptions:* Volcanoes can affect the climate because they can emit aerosols and carbon dioxide into the atmosphere.
- *Aerosol emissions:* Volcanic aerosols tend to block sunlight and contribute to short term cooling. Aerosols do not produce long-term change because they leave the atmosphere not long after they are emitted. According to the United States Geological Survey (USGS), the eruption of the Tambora Volcano in Indonesia in 1815 lowered global temperatures by as much as 5°F and historical accounts in New England describe 1816 as "the year without a summer."
- *Carbon dioxide emissions:* Volcanoes also emit carbon dioxide (CO_2), a greenhouse gas, which has a warming effect. For about two-thirds of the last 400 million years, geologic evidence suggests CO_2 levels and temperatures were considerably higher than at present. While volcanoes may have raised prehistoric CO_2 levels and temperatures, according to the USGS Volcano Hazards Program, human activities now emit 150 times as much CO_2 as volcanoes.

These climate change "drivers" often trigger additional changes or "feedbacks" within the climate system that can amplify or dampen the climate's initial response to them (whether the response is warming or cooling). For example:

- *Changes in greenhouse gas concentrations:* The heating or cooling of the Earth's surface can cause changes in greenhouse gas concentrations. For example, when global temperatures become warmer, carbon dioxide is released from the oceans. When changes in the Earth's orbit trigger a warm (or interglacial) period, increasing concentrations of carbon dioxide may amplify the warming by enhancing the greenhouse effect. When temperatures become cooler, CO_2 enters the ocean and contributes to additional cooling. During at least the last 420,000 years, CO_2 levels have tended to track the glacial cycles (IPCC, 2001). That is, during warm interglacial periods, CO_2 levels have been high and during cool glacial periods, CO_2 levels have been low (see Figure 1.)

Figure 1: Fluctuations in temperature (red line) and in the atmospheric concentration of carbon dioxide (yellow) over the past 649,000 years. The vertical red bar at the end is the increase in atmospheric carbon dioxide levels over the past two centuries and before 2007.



Source: United States Environmental Protection Agency. (2008, March 24). *Climate change*. Retrieved February 4, 2009, from http://www.epa.gov/climatechange/science/pastcc_fig1.html

- Changes in ocean currents: The heating or cooling of the Earth's surface can cause changes in ocean currents.

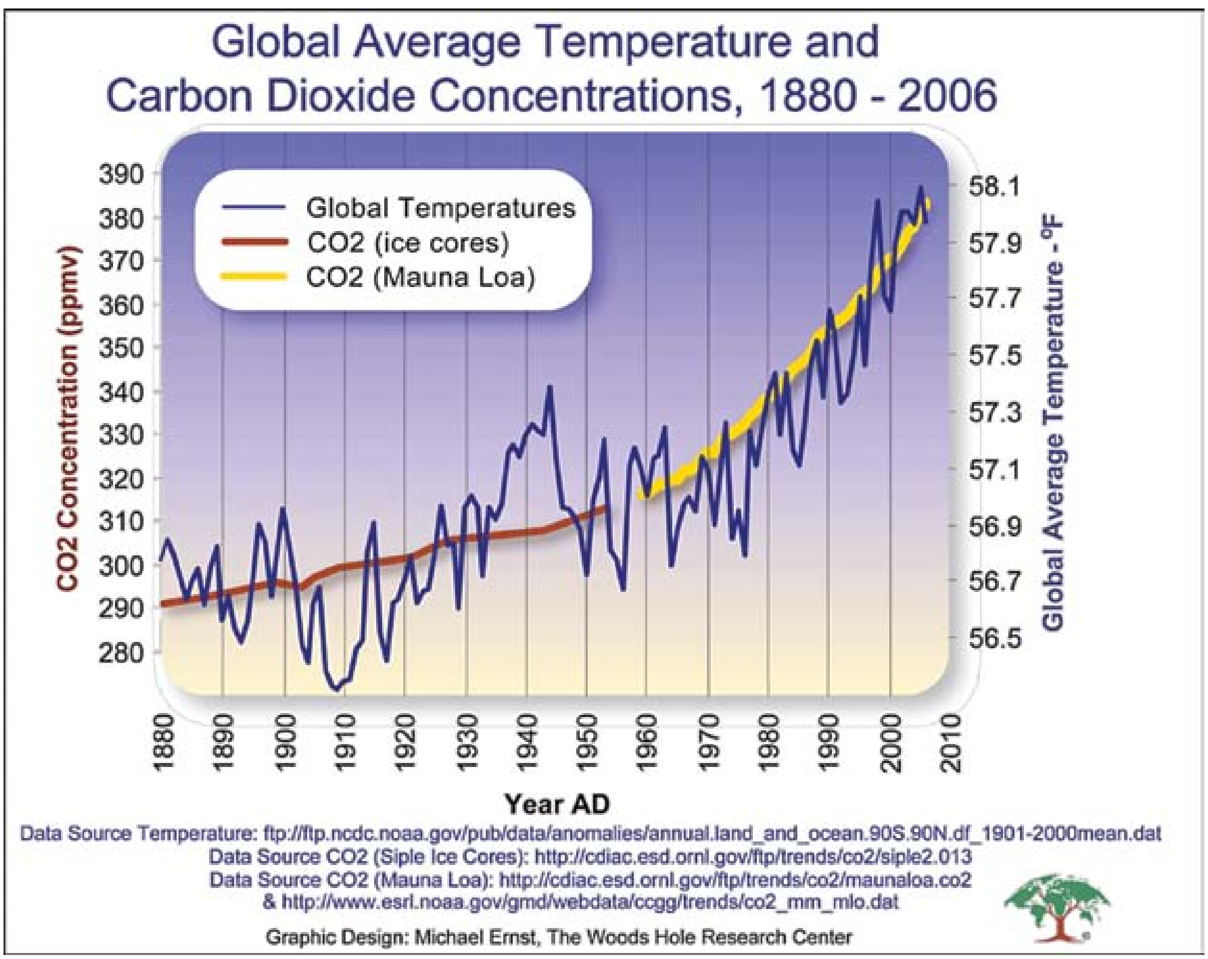
Reading #2: Recent Scientific Evidence

Betne | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Source: Woods Hole Research Center. (2008). *Scientific evidence: increasing temperatures & greenhouse gases*. Retrieved February 4, 2009, from http://www.whrc.org/resources/online_publications/warming_earth/scientific_evidence.htm

Accumulating Evidence
Other evidence of the reality of global warming continues to accumulate. Consistent with predictions of the IPCC since 1990, global average temperatures have indeed been rising while atmospheric CO_2 increases at a rate of approximately 1.6ppm per year (see graph below).

Figure 2



Household Electricity Consumption (Learning Communities Version)

Marina Dedlovskaya, Department of Mathematics, Engineering, and Computer Science
Patricia Sokolski, Humanities Department

Project Quantum Leap

Objectives

This assignment emerges from a paired course between Introduction to Algebra and Critical Thinking using the SENCER model to engage students in thinking about the environment. Thinking about the environment can be overwhelming because people sometimes feel that we can't really do anything about it and that it is a much bigger problem than us. Therefore, we designed this project to bring the issue of the environment back to each of us and to encourage students to use math principles to think critically about their energy consumption and, ideally, change their habits.

By examining environmental issues, such as global warming, recycling, and pollution, students will understand and use math for real-world situations, and develop the critical thinking tools to make informed decisions regarding the impact of the environment on our society as well as in their own personal lives.

In this project, students will learn:

MAT095: The basic mathematical skills necessary to evaluate the electricity consumption (in dollars and in CO_2) of home appliances.

HUP102: How to set short-term goals and accomplish them. Students will also learn to analyze the "local and global" effects of the reduced use of the appliances they choose to study.

Math Topics
Simple average, decimals, operations on whole numbers

Purpose
Motivation and synthesis

Comments
This activity is part of a project done in a Math and the Environment Learning Community consisting of two courses: Introduction to Algebra (MAT095) and Critical Thinking (HUP102)

When to Introduce
Week 1 for data collection, week 3 or 4 for data analysis

Activity Time Frame
Four weeks: two weeks to collect data, one week for discussion and one week for writing. It is important to leave enough time for all students to get seven days of data collection. Since collecting data does not require specific knowledge, one can start this assignment by the end of the first week of class.

Reflection

Introduction to Algebra (MAT095) is a developmental mathematics course designed for students with little or no algebra background. It emphasizes the importance of quantitative reasoning in addressing real-world problems and builds mathematical skills necessary to solve them. The problem-solving approach used in the course is based on the ideas of Science Education for New Civic Engagements and Responsibilities (SENCER). The goal is to motivate the teaching of math i n the context of complex and compelling public issues.

Critical Thinking (HUP102) explores the process of thinking critically and guides students in thinking more clearly, insightfully, and effectively. Concrete examples from students' experience and contemporary issues help students develop the abilities to solve problems, analyze issues, and make informed decisions in their academic, career, and personal lives.

This version is the second iteration of the project. The first time we started directly with data collection, but this time we added an activity to raise students' awareness about the problems of the environment. Students watch *An Inconvenient Truth,* calculate their ecological footprints, and engage in a discussion about our impact on the environment. Students collect data and practice doing calculations that are required in the project. However, as we noticed previously, the students had a difficult time analyzing the data because their calculations were not accurate.

We measure the success of the project in the quality of the essay. We look for essays that integrate math concepts and critical thinking as they relate to the issue of our energy consumption. We expect the essays to include references to the data the students have collected through the exercise and analysis of the impact of the exercise on their daily lives.

The second time around, students had no problem collecting the data, but even with the extra practice in calculation, they still had difficulty with quantitative literacy. Sometimes they forgot to check the accuracy of their calculations and ended up with interesting interpretations because they failed to see the meaning of the numbers. Compared to the first time we did this project, the accuracy was much higher.

Yet, even with inaccurate data, the reflection papers did show an increase in students' understanding of their impact on the planet. Some were shocked at how much time they used certain appliances, while others reflected on what they did when they were not using their computers. While these examples show students' ability to think critically about the issue, the ways they used mathematical calculations as evidence to support their argument were not elementary. As to whether this activity would help change students' behavior, the overall outcome is somewhat disheartening, for most of our students admitted they were not prepared to make sacrifices to save money or reduce CO_2 emissions.

Activity Overview

Week 1
In HUP102 class: Achieving short-term goals.

In HUP102 class (Part I of Handout #2): Introduce the activity and give a list of appliances that students can use for collecting data. Start data collection.

In HUP102 class (homework assignment): Calculate ecological footprint using http://www.earthday.net/footprint. This exercise shows students how many planets we would need if everybody continued to consume at their current rates. Students take the footprint quiz online and bring their results to class. Since the results are divided into categories (shelter, food, mobility, services) students can compare the impact of their lifestyles with each other and reflect on what category has the greatest impact.

Week 2
In HUP102 class (Handout #1): Achieving short-term goals: Students reflect on goals they have accomplished, such as graduating from high school, then make the completion of this project a short-term goal that is part of the long-term goal of passing this paired class.

In MAT095 class (Handout #2): Lesson on energy consumption: Students practice calculation with data for a dishwasher, so they can do the same when they collect their own data. The lesson teaches students how to convert watts to kilowatts, then to kilowatts per hour.

Week 3
In MAT095 class (homework assignment: Part II of Handout #2): Calculate energy consumption with data collected.

In HUP102 class: Check to see if students are following the steps to complete the project. By that time, they are supposed to have collected the data and should be ready to discuss its impact. Students who are not ready create new plans to catch up.

Week 4
In HUP102/MAT095 classes (Handout #1 homework assignment): Students write a reflection essay on achieving the goal of reducing energy consumption and analysis of the data and the impact on student lifestyle. The essay must include an analysis of the data.

Materials and Resources

- Handout #1: Our Energy Consumption – Project Guideline
- Handout #2: Data Collection and Analysis
- Chaffee, J. (2006). *Thinking critically* (8th ed.). Boston: Houghton Mifflin. Chapter 1.
- Guggenheim, D. (Director). (2006). *An Inconvenient Truth*. Paramount Home Entertainment.

Handout #1: Our Energy Consumption

Dedlovskaya & Sokolski | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095, HUL102)

Project Guidelines

First week: Part I Data Collection
Pick three appliances in your house and record the number of minutes/hours you use them per day for seven days.

Beginning of second week: Short-term goals
Think about the minimum amount of time you could use each appliance and how reduced usage would impact your daily life. Start reducing the amount of time you use the appliances.

Seven more days (end of second week): Reflection
Reflect on how you reached your goal of reducing the consumption of energy for the chosen appliances and note how doing so has impacted your daily life.

Third week: Part II Data Analysis
Bring in your notes and discuss your experience with other students. Compare how much energy/money you have saved in this experiment. Would you be willing to use those appliances less on a permanent basis? Give specific reasons to support your answer.

Fourth week: Reflection Paper due
Reflect on your experience using both critical thinking skills and math concepts.

How much energy and money have you saved by using these appliances differently? How did math help you to understand and complete this project? Explain your answer.

What were your ideas about each individual's impact on the environment before and after this experiment?

Handout #2: Data Collection and Analysis

Dedlovskaya & Sokolski | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095, HUL102)

Part I: Data Collection

1. Choose three appliances in your home that you use regularly.
2. Record how many minutes per day you use each of these appliances in a given week.
3. Organize your data in the table below. Write the names of your three chosen appliances on the top row of the table.
4. Can you reduce your use of any of these appliances? If so, record your reduced data in the table.

	APPLIANCE 1		APPLIANCE 2		APPLIANCE 3	
Day	Current use (min./day)	Reduced use (min./day)	Current use (min./day)	Reduced use (min./day)	Current use (min./day)	Reduced use (min./day)

Part II: Data Analysis

1. Using the data you collected for each appliance, calculate the following:

   a. Current and reduced total use, in minutes, for each appliance over the course of 7 days

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Current total use for 7 days (in minutes)			
Reduced total use for 7 days (in minutes)			

   b. Daily use, in minutes, of each appliance

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Current daily use (in minutes per day)			
Reduced daily use (in minutes per day)			

2. Convert the daily use for each appliance from minutes per day to hours per day:

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Current daily use (in hours per day)			
Reduced daily use (in hours per day)			

3. Determine the power (in kilowatts) of each of your appliances and list it in the table below:

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Power in kilowats			

4. Calculate the electricity consumption (in kilowatt-hours) for each appliance using the following formula:

$$C = P \times U$$

   where C = consumption in kilowatt-hours (kWh); P = power (in kilowatts); and U = use (in hours).

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Current daily consumption (in kilowatt-hours)			
Reduced daily consumption (in kilowatt-hours)			

Household Electricity Consumption (Learning Communities Version)

5. Calculate the amount of electricity consumed by all three appliances together per day (current and reduced):
   Current electricity consumption = ____
   Reduced electricity consumption = _______________________________________

6. Calculate the difference between the current and reduced daily electricity consumption:
   Difference = ____

7. How much electricity could be saved in 1 year at the reduced rate?
   Electricity saved = ____

8. 1 kWh of electricity produces 1.535 lbs of CO-1 pt. Using your results from part 7, calculate the reduction of CO-1 pt emissions in 1 year.
   Reduction of CO_2 emissions = ____

9. Calculate the savings in dollars that would result from the reduced rate, based upon an average retail cost of electricity per kilowatt-hour in New York State of $0.1619.
   Savings (in dollars) = ____

Household Electricity Consumption: Focus on Math

Marina Dedlovskaya
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

One of the major goals of this activity is to teach students how to use and critically evaluate numerical information to understand their electricity consumption and its impact on the environment. Through this activity students will acquire knowledge of collecting, analyzing, and interpreting quantitative data. The activity will engage students in learning basic math concepts, such as averages, operations with decimals, and evaluation of algebraic expressions.

Math Topics
Decimals, basic algebra, proportions

Purpose
Introduction (decimals) and synthesis (simple average, basic algebra)

Comments
Based on data collection

When to Introduce
Week 1

Activity Time Frame
Four weeks

Part 1: Analyzing dishwasher energy consumption should be done in class during the second week.

Part 2: Collecting and analyzing data for three home appliances should be assigned in the first week and results submitted during Week 3.

Part 3: Reflection paper

Reflection

One of the main goals of Introduction to Algebra is to develop students' ability to operate with numbers in different formats, such as fractions, decimals, and percents, and to use simple formulas and equations to solve problems. We believe that teaching mathematics in the context of environmental issues makes the concepts easy to understand. This approach also helps students to see the relevance of mathematics to the real world, and demonstrates the importance of numerical data in the decision-making process. Using the environment as a common theme for our integrated pair of MAT095 and HUP102, we decided to bring the discussion of energy consumption to the personal level. We wanted our students to think about their household electricity consumption and how it affects the environment in terms of CO_2 emission and global warming. We asked them whether they were willing to change their habits to reduce their energy consumption, by weighing how such change would affect both their budget and comfort.

In the "Household Electricity Consumption" project, students reviewed all mathematical notations involved in the activity twice (once in class, then again at home), which helped them to master their skills. In the Critical Thinking class (HUP102), students were asked to collect data for one full week on the use of three appliances in their homes. They were also asked to consider reducing their use and to collect usage data after their reduction in use. To guide students with calculations, in class the instructors provided Handout #1 which contained data on dishwasher use by minute. This in-class activity allowed students to review the process and practice their skills later at home when they were working on the data they had collected for their own chosen appliances. As I expected, the data collection and data interpretation components went smoother than the calculations. Two sets of data were given to students: one for present use, and the other for a hypothetical reduced use. I found that some students found it confusing to go back and forth between two sets of data. I am currently teaching the same integrated pair again, and I think it would be clearer for students if I separated the data sets and asked students to work out data for the current electricity consumption first, and then to repeat the same process using data for reduced electricity consumption.

Students are not entirely enthusiastic about the idea of learning mathematics through the environment. However, I do think that many of them see the point. Some diligent students improved their math skills, and passed the COMPASS and moved to MAT096. The reflection papers that the students submitted in critical thinking class confirmed that there had been an increase in students' awareness of their impact on the environment. Some of them were surprised by the fact that they use certain appliances much more than they anticipated. However, in their papers students admitted that they were not prepared to change their behavior if doing so would compromise their comfort. Even though I admired their honesty, I think that next time I will emphasize their responsibilities as global citizens who all have a stake in the health of the earth. We math professors have an important mission: to provide students with the analytical skills to understand the environmental challenges we are facing.

Activity Overview

Class Discussion

Before the Household Electricity Consumption activity is introduced in math class, students watch *An Inconvenient Truth* by Al Gore in their Critical Thinking class and calculate their ecological footprints at: http://www.footprintnetwork.org/gfn_sub.php?content=myfootprint. A class discussion based on the questions below prepares students to think about ways to evaluate our impact on the environment. The discussion is conducted in the Critical Thinking class.

- What is global warming?
- What causes it?
- Why should we save energy?
- What can be done at a personal level to reduce electricity consumption?

MAT095 Class Exercises

Students receive Handout #1, Household Electricity Consumption (Dishwasher), which demonstrates how to collect and organize data for an appliance using a dishwasher as an example. All questions from the handout should be answered in class with the help of the instructor. Students will use Handout #2 to evaluate the electricity consumption of three appliances from their homes. It includes a table to record data and questions identical to the questions they answered in class.

Assignment

Students are asked to collect data and answer the questions by repeating the process they have done in class for the dishwasher. They are expected to evaluate the electricity consumption of three types of appliances – TVs, computers, and light bulbs – on their own and reflect on their work afterward. Students submit all calculations to the Math instructor and the reflection essay to the Critical Thinking instructor.

Materials and Resources

Handouts are the same as those used in the Learning Communities version of this activity. See prior lesson.

- Handout #1: How Much Electricity Does that Dishwasher Use?
- Handout #2: Data Collection and Analysis
- Global Footprint Network. (2008, December 30). *Footprint basics – overview*. Retrieved February 4, 2009, from http://www.footprintnetwork.org/en/index.php/GFN/page/footprint_basics_overview/

Handout #1: How Much Electricity Does That Dishwasher Use?

Dedlovskaya | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095, HUL102)

In-class practice. Examine the data provided in the table below:

Electricity Consumption (Dishwasher)

Day	Current use (minutes per day)	Reduced use (minutes per day)
Monday	162	65
Tuesday	45	0
Wednesday	83	30
Thursday	104	35
Friday	45	32
Saturday	0	30
Sunday	147	62

1. Using the data provided for a dishwasher, find the following:
   a. Total use, in minutes, for 7 days
      Current = ________________ Reduced = ________________
   b. Daily use, in minutes
   Current = ____________________ Reduced = ________________

2. Convert the daily use in part 1 from minutes per day to hours per day.
   Current = ____________________ Reduced = ________________

3. Calculate daily electricity consumption (in kilowatt-hours) using the following formula

   $$C = P \times U$$

   where C = consumption (in kilowatt-hours); P = power (in kilowatts); and U = use (in hours).
   Note: The power of a typical dishwasher is 1200 kw.
   Current = ____________________ Reduced = ________________

4. Calculate the difference between the current and reduced daily electricity consumption.
   Difference = ____

5. How much electricity could be saved in 1 year at the reduced rate?
   Electricity saved = ____

6. 1 kWh of electricity produces 1.535 lbs of CO_2. Using your results from part 7, calculate the reduction of CO_2 emissions in 1 year.
   Reduction of CO_2 emissions = ________________________________

7. Calculate the savings in dollars that would result from the reduced rate, based upon an average retail cost of electricity per kilowatt-hour in New York State of $0.1619.
   Savings (in dollars) = ____

Answers:

Saving per day =	0.96 kWh (kilowatt hour)	Savings per day =	$0.15
Savings per year =	$54.75	1kWh of electricity produces 1.535 lbs of CO_2	

Saving 0.96 kWh per day, we reduce the amount of CO_2 emissions by 1.4736 lbs, which is about 538 lbs of CO_2 emissions in one year.

Handout #2: Data Collection and Analysis

Dedlovskaya | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095, HUL102)

Part I: Data Collection

1. Choose three appliances in your home that you use regularly.
2. Record how many minutes per day you use each of these appliances in a given week.
3. Organize your data in the table below. Write the names of your three chosen appliances on the top row of the table.
4. Can you reduce your use of any of these appliances? If so, record your reduced data in the table.

	APPLIANCE 1		APPLIANCE 2		APPLIANCE 3	
Day	**Current use (min./day)**	**Reduced use (min./day)**	**Current use (min./day)**	**Reduced use (min./day)**	**Current use (min./day)**	**Reduced use (min./day)**

Part II: Data Analysis

1. Using the data you collected for each appliance, calculate the following:

   a. Current and reduced total use, in minutes, for each appliance over the course of 7 days

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Current total use for 7 days (in minutes)			
Reduced total use for 7 days (in minutes)			

   b. Daily use, in minutes, of each appliance

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Current daily use (in minutes per day)			
Reduced daily use (in minutes per day)			

2. Convert the daily use for each appliance from minutes per day to hours per day:

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Current daily use (in hours per day)			
Reduced daily use (in hours per day)			

3. Determine the power (in kilowatts) of each of your appliances and list it in the table below:

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Power in kilowats			

4. Calculate the electricity consumption (in kilowatt-hours) for each appliance using the following formula:

$$\boldsymbol{C} = \boldsymbol{P} \times \boldsymbol{U}$$

where $\boldsymbol{C}$ = consumption in kilowatt-hours (kWh); $\boldsymbol{P}$ = power (in kilowatts); and $\boldsymbol{U}$ = use (in hours).

	APPLIANCE 1	APPLIANCE 2	APPLIANCE 3
Current daily consumption (in kilowatt-hours)			
Reduced daily consumption (in kilowatt-hours)			

5. Calculate the amount of electricity consumed by all three appliances together per day (current and reduced):
   Current electricity consumption = ___________________________________
   Reduced electricity consumption = __________________________________
6. Calculate the difference between the current and reduced daily electricity consumption:
   Difference = ____
7. How much electricity could be saved in 1 year at the reduced rate?
   Electricity saved = ____
8. 1 kWh of electricity produces 1.535 lbs of CO-1 pt. Using your results from part 7, calculate the reduction of CO-1 pt emissions in 1 year.
   Reduction of CO_2 emissions = _____________________________________
9. Calculate the savings in dollars that would result from the reduced rate, based upon an average retail cost of electricity per kilowatt-hour in New York State of $0.1619.
   Savings (in dollars) = ____

Dust Clouds: Height and Thickness

Yasser Hassebo
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

The main mathematical objective of this assignment is to gain understanding of environmental issues and dust clouds' impact on human daily life through geometric analysis and mathematical theories. Also, the assignment aims to encourage students to recognize how their mathematical topics in Introduction to Algebra (MAT095) are very useful for understanding the world around us. This activity is a staged assignment. The Motivation stage starts with a PowerPoint presentation by the instructor about sources of air pollution transportation and scientific techniques for understanding past environmental disasters in NYC, including the plume-cloud event in 2004. This stage is followed by an Introduction stage, which discusses math assignments that ask students to calculate plume-cloud height and thickness using the Light Detection and Ranging (LIDAR) technique and math theory (Pythagorean Theorem). Students are also required in the third stage to use LaGuardia's ePortfolio to deposit their final work, a means of reinforcing the use of technology (computers, scanners, the web, Microsoft Word and Excel), which is a secondary goal of the assignment. In addition, students review mathematical concepts and operations with radicals and square roots, rules of exponents, and the concepts of slope and linear equations.

Math Topics
Pythagorean Theorem, exponents and radicals, linear equations determination, slope, graphical interpretation

Tools
Multimedia projector, computer and Internet connection

When to Introduce
This activity should be introduced in the beginning of the eighth week of the semester

Activity Time Frame
One week

Reflection

As I began to plan my pedagogical strategy in the classroom, I believed that the relationship between environmental pollution, global warming and the dust cloud above NYC would be an engaging topic for our students, and broad enough for me to plan my lesson around. I think the preparation stage was very successful. Following the PowerPoint presentation "Why Do We Care?" my students participated actively in a discussion that took place in class. Students were very interested in discovering, for the first time, the ways in which air pollution transportation, forest fires, and dust and plume clouds produce dangerous chemicals in their own neighborhoods and impact their lives and health.

The math activity was intended to strengthen students' understanding of the Pythagorean Theorem, radicals, linear equations, and slope. Another goal was to have students understand that mathematical calculations can increase their ability to understand concepts. I introduced the math activity directly after the PowerPoint presentation and in-class discussion. Students' responses were outstanding. Most of the students submitted the project before the due date. The majority used computers (Microsoft Excel, Word, and scanners) to do the math calculations, graphs, and reflections. On one particularly memorable day, the entire class followed me voluntarily after a lecture to a computer lab to deposit their final work into the LaGuardia ePortfolio.

Activity Overview

1. The activity starts with a PowerPoint presentation by the instructor about sources of air pollution transportation and scientific techniques for understanding environmental disasters in NYC, including the plume event in 2004 (see Handout #1).

2. In class, students are given a short reading about dust clouds and air pollution transportation in the environment. They read it individually and practice asking questions about the reading (especially about LIDAR). For example, they ask about remote sensing and what will happen if the earth's temperature increases by 2 degrees, and what the earth's average temperature is (see Reading).

3. This activity is followed by a math assignment that asks students to calculate the dust cloud height and thickness using the LIDAR technique and an effective math theory (the Pythagorean Theorem). We discuss the project in class, and then I allow one week to submit and/or deposit their final work into Blackboard (see Handout #2).

4. The homework assignment is to use the given web citations to research LIDAR for extra credit. Then, students must write a reflection and post it to their ePortfolio to earn credit (see Handout #2).

5. These questions were designed to encourage students to use math skills learned in the classroom to establish graphs and comparisons, to calculate numbers from graphs, and finally to understand the scale of these issues and how they impact the world around them.

6. The math activity answer sheet is also provided to enhance students' learning and for self-assessment purposes (see Handout #2).

Materials and Resources

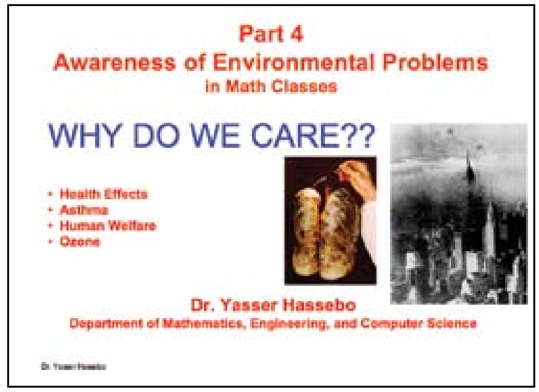
- Handout #1: PowerPoint presentation – Why Do We Care?
- Handout #2: Math Activity
- Reading
- Environmental Network News (n.d.) *Dust particles have global impact.* Retrieved February 14, 2009, from http://www.cartage.org.lb/en/themes/Sciences/EarthScience/Geology/Deserts/Dustparticles/Dustparticles.htm
- Kalkstein, L. S., & K. M. Valimont. 1987. Climate effects on human health. In *Potential effects of future climate changes on forests and vegetation, agriculture, water resources, and human health*. EPA Science and Advisory Committee Monograph no. 25389, 122–52. Washington, D.C.: U.S. Environmental Protection Agency. Retrieved February 13, 2009, from http://www.ciesin.columbia.edu/docs/001-338/001-338.html
- National Center for Atmospheric Research News Release. (2007) *Scientists to track impact of Asian dust and pollution on clouds, weather, climate change.* Retrieved February 13, 2009, from http://www.ucar.edu/news/releases/2007/pacdex.shtml
- NASA. (n.d.) Retrieved February 13, 2009, from http://search.nasa.gov/search/search.jsp?nasaInclude=what+is+lidar

- Planet Ark: Your Daily Guide to Helping the Planet. (2005, November 2). C*limate change linked to rise in malaria, asthma*. © Thomson Reuters 2005 All rights reserved. Retrieved February 13, 2009, from http://www.planetark.com/dailynewsstory.cfm/newsid/33285/story.htm
- Science Daily. (2008, February 10.) *Dust storms in Sahara Desert trigger huge plankton blooms in eastern Atlantic*. Retrieved February 14, 2009, from http://www.sciencedaily.com/releases/2008/02/080206192436.htm
- Science Daily. (2008, May 8.) *Farmland dust cloud from Ukraine impacts air quality as far as Germany*. Retrieved February 14, 2009, from http://www.sciencedaily.com/releases/2008/05/080506105139.htm

Handout #1: Why Do We Care?

Hassebo | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095

PowerPoint presentation



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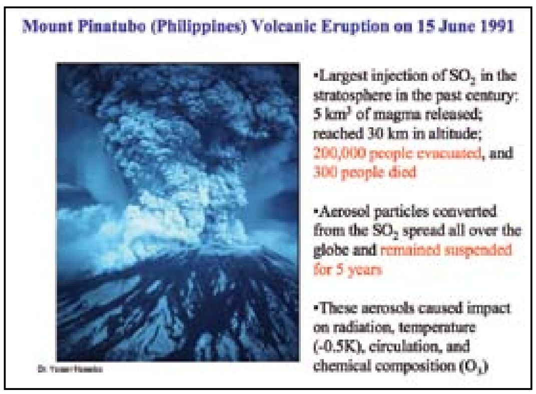

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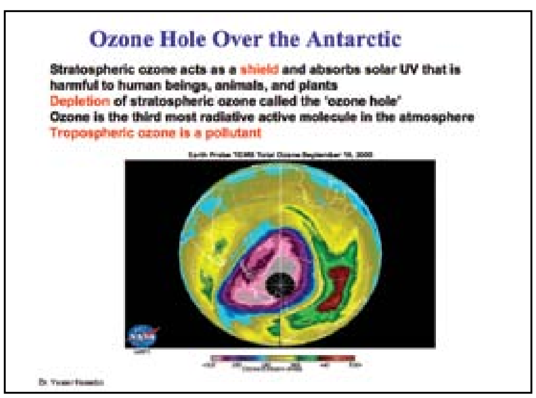

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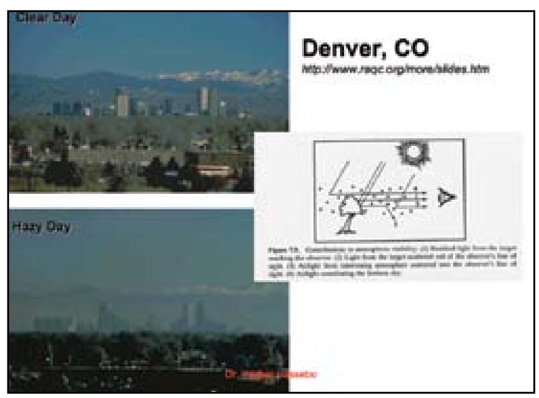

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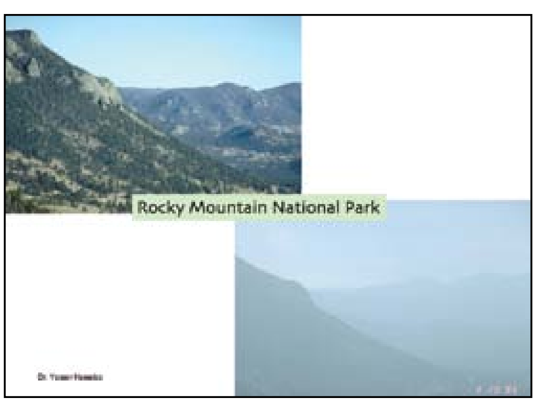

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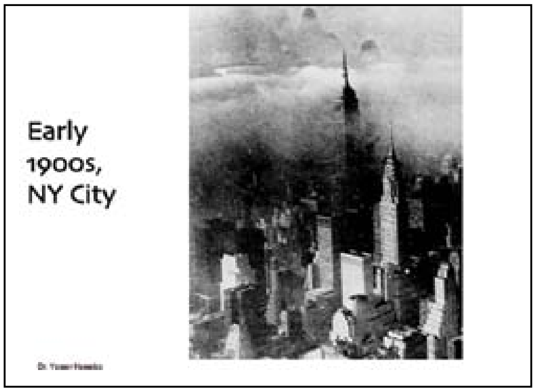

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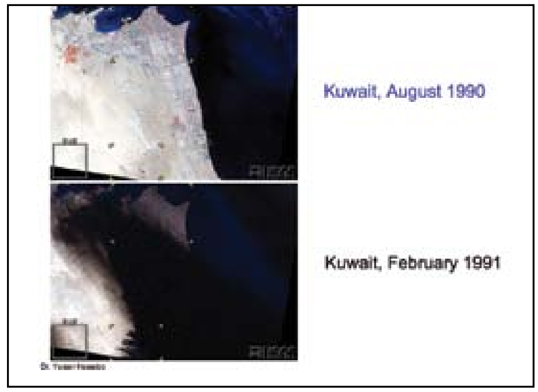

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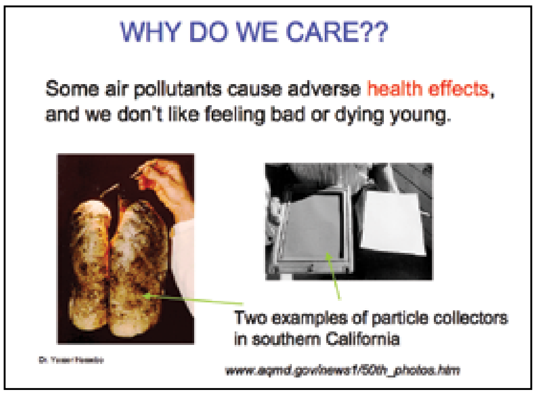

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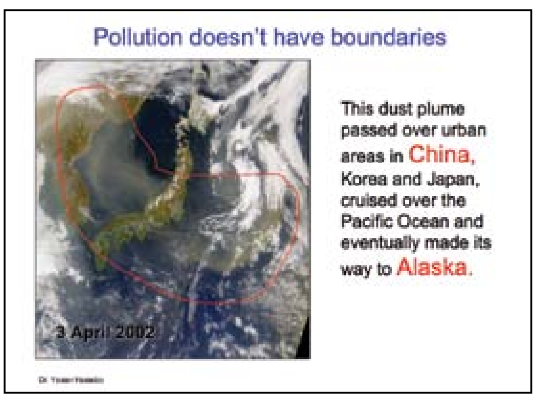

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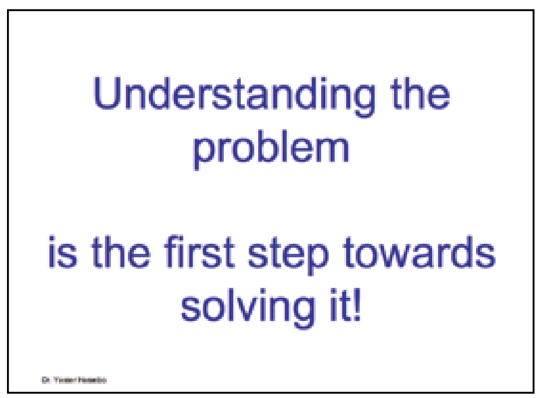

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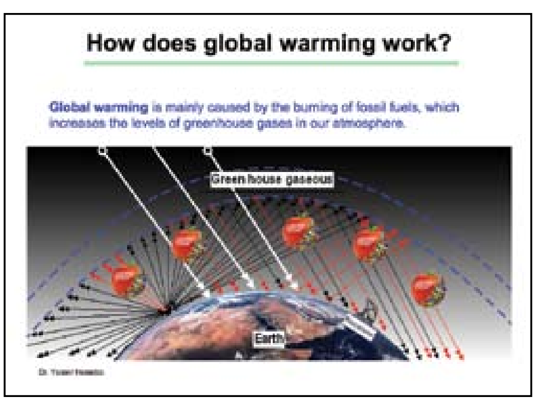

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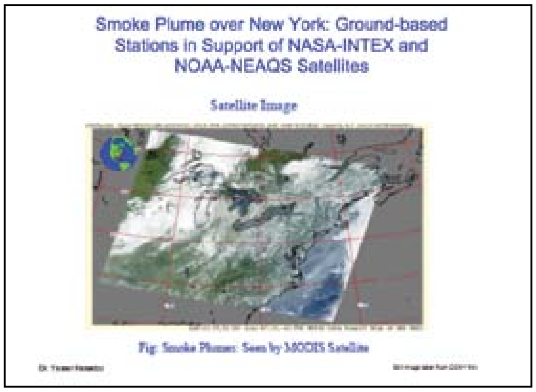

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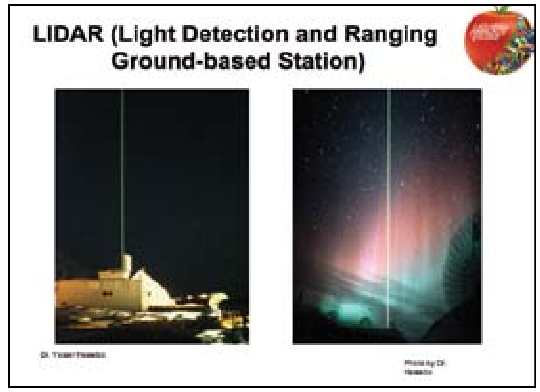

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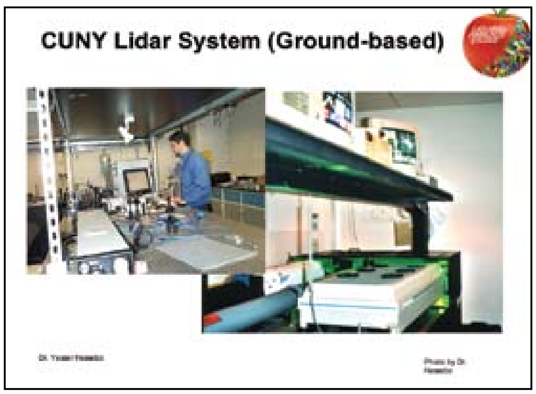

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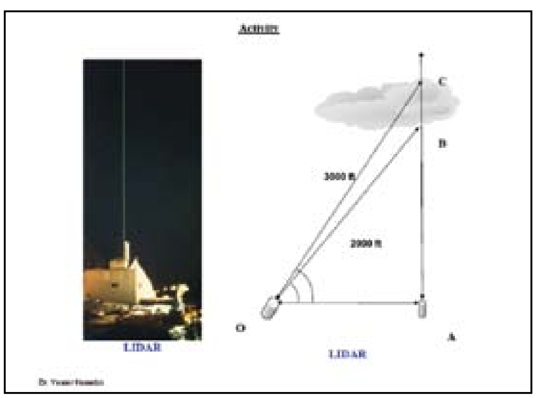

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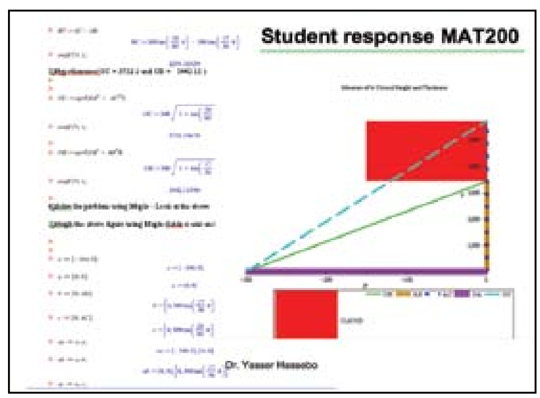

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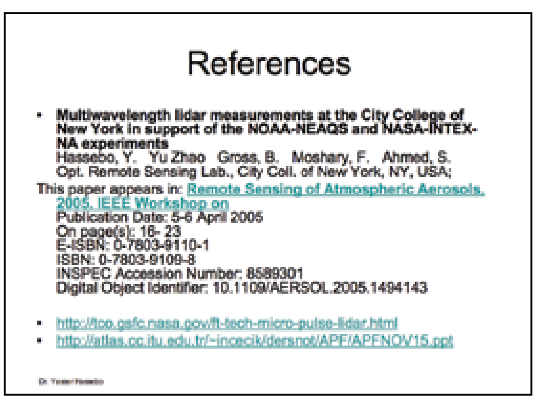

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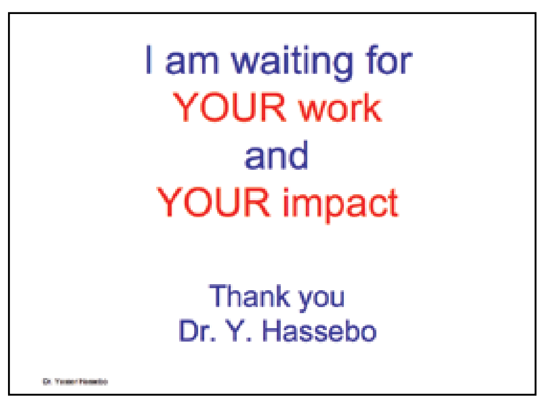

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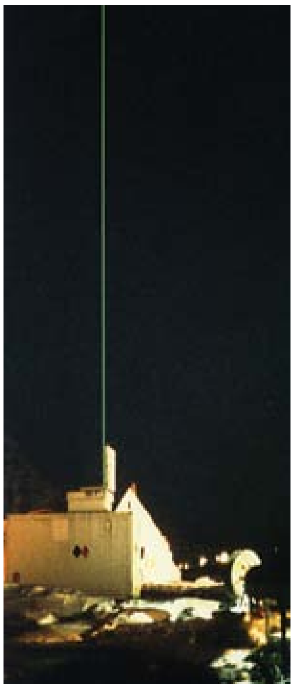
Handout #2: Math Activity

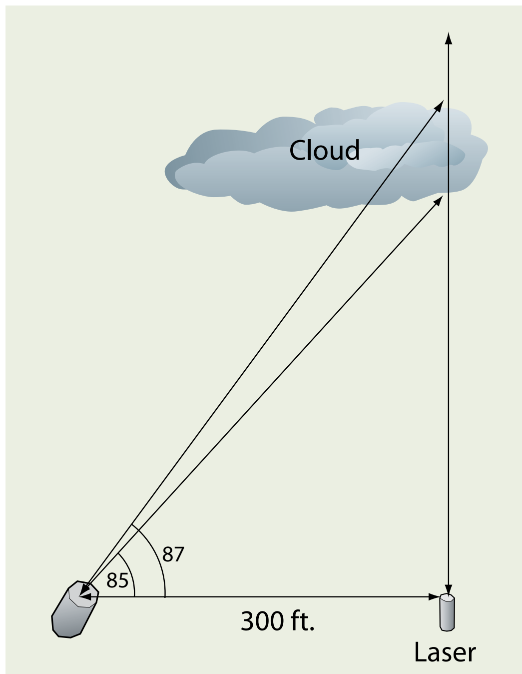
Hassebo | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095

(Pythagorean Theorem, exponents, radicals and square roots, linear equations, graphing skills)

In preparation for our in-class discussion and your homework, read the attached material.



LIDAR



LIDAR

Light Detection and Ranging (LIDAR) is a remote sensing tool to probe the atmosphere. LIDAR can be used to measure a dust cloud's ceiling (cloud bottom height from the ground level) and its thickness. A LIDAR system at LaGuardia Community College transmits a laser beam from the ground level vertically to the atmosphere. The laser beam scatters back from the cloud (bottom and top) to the receiver (300 ft from the laser). If the lines ***OB***=2000 ft, and ***OC***=3000 ft, calculate the following:

In-class discussion and homework

1. The dust cloud ceiling (***AB*** = ? ft)
2. The dust cloud thickness (***BC*** = ? ft)
3. Write the ordered pairs of the points ***O***, ***B***, and ***C***, assuming ***A*** is the origin point (0,0).
4. Find the linear equations of the line ***OB*** and the line ***OC*** in slope intercept form (given two points). Note: the direction of line ***OB*** is from ***B*** to ***O***.

Extra credit homework

Use the Internet links cited below to answer the following questions:

- What is LIDAR?
- Graph the above figure using any computer program (write x-axis and y-axis labels, and the title)

Reflection

- What is the impact of dust on global warming?
- What is the impact of global warming on human health in New York City?

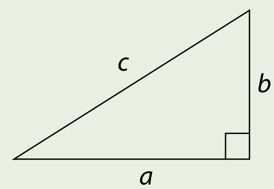
References:

- Environmental Network News (n.d.) *Dust particles have global impact.* Retrieved February 14, 2009, from http://www.cartage.org.lb/en/themes/Sciences/EarthScience/Geology/Deserts/Dustparticles/Dustparticles.htm
- Kalkstein, L. S., & K. M. Valimont. 1987. Climate effects on human health. In *Potential effects of future climate changes on forests and vegetation, agriculture, water resources, and human health*. EPA Science and Advisory Committee Monograph no. 25389, 122-52. Washington, D.C.: U.S. Environmental Protection Agency. Retrieved February 13, 2009, from http://www.ciesin.columbia.edu/docs/001-338/001-338.html
- NASA. (n.d.) Retrieved February 13, 2009, from http://search.nasa.gov/search/search.jsp?nasaInclude=what+is+lidar
- Planet Ark: Your Daily Guide to Helping the Planet. (2005, November 2). C*limate change linked to rise in malaria, asthma*. © Thomson Reuters 2005 All rights reserved. Retrieved February 13, 2009, from http://www.planetark.com/dailynewsstory.cfm/newsid/33285/story.htm
- Science Daily. (2008, February 10.) *Dust storms in Sahara Desert trigger huge plankton blooms in eastern Atlantic*. Retrieved February 14, 2009, from http://www.sciencedaily.com/releases/2008/02/080206192436.htm
- Science Daily. (2008, May 8.) *Farmland dust cloud from Ukraine impacts air quality as far as Germany*. Retrieved February 14, 2009, from http://www.sciencedaily.com/releases/2008/05/080506105139.htm

Math Activity Answer Sheet

1. The dust cloud ceiling (***AB*** = ? ft)
   To calculate the dust cloud ceiling, we use the Pythagorean Theorem:

For a right triangle with leg a, leg b, and hypotenuse c



Then $c^2 = a^2 + b^2$

$(\text{hypotenuse})^2 = (\text{leg\_1})^2 + (\text{leg\_2})^2$

or $\text{hypotenuse} = \sqrt{(\text{leg\_1})^2 + (\text{leg\_2})^2} = \sqrt{(a)^2 + (b)^2}$

Or to calculate Leg_2

$$\text{leg\_2} = b = \sqrt{(\text{hypotenuse})^2 - (\text{leg\_1})^2} = \sqrt{(c)^2 - (b)^2}$$

Then in our problem, for the small triangle (*OAB*): *a*= 300, *c*= 2000, *b*=?

$$b = AB = \sqrt{(c)^2 - (a)^2} = \sqrt{(2{,}000)^2 - (300)^2} = \sqrt{4{,}000{,}000 - 90{,}000} = \sqrt{3{,}910{,}000} = 1{,}977.4 \text{ ft.}$$

2. The dust cloud thickness (***BC*** = ? ft)
   To calculate the cloud thickness (***BC***), we need to calculate the height (***AC***) in the bigger triangle (***OAC***). Then using the cloud ceiling and the height (***AC***), we can calculate BC as follows:
   BC = ***AC*** – ***ABBC*** = ***AC*** – ***AB*** = 2984.9-1977.4= 1007.5 ft

For the bigger triangle (*OAC*): *OA* = 300, *OC*= 3000, *AC*=?

$$AC = \sqrt{(OC)^2 - (OA)^2} = \sqrt{(3{,}000)^2 - (300)^2} = \sqrt{9{,}000{,}000 - 90{,}000} = \sqrt{8{,}910{,}000} = 2{,}984.9 \text{ ft.}$$

3. Write the ordered pairs of the points ***O***, ***B***, and ***C***, assuming ***A*** is the origin point (0,0).

Assuming *A* is the origin point (0, 0)

Point *O* = (-300, 0)

Point *B* = (0, 1977.4)

Point *C* = (0, 2984.9)

4. Find the linear equations of the line ***OB*** and the line ***OC*** in slope-intercept form (given two points).

To find linear equations of the line *OB* in the slope-intercept form $Y = mX + B$, we have to calculate the slope *m*, and the *y*-intercept *b*:

1. Calculating the slope using the two points: point $O = (x_1, y_1) = (-300, 0)$ and point $B = (x_2, y_2) = (0, 1{,}977.4)$

$$\text{Then slope } m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{1{,}977.4 - 0}{0 - (-300)} = \frac{1{,}977.4}{300} = 6.6$$

2. Find the linear equation using: $Y - y_1 = m(X - x_1)$ fi $Y - 0 = 6.6(X - (-300))$

$$Y = 6.6x - 1980$$

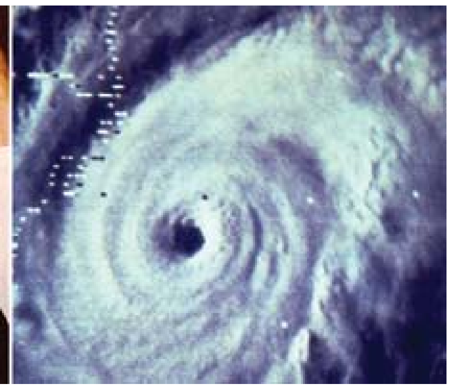
Reading

Hassebo | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

The Impact of Dust Clouds on Health and the Environment

(Pythagorean Theorem, exponents, radicals and square roots, linear equations, graphing skills)





Dust Clouds and Hurricanes

“By partly absorbing and partly reflecting sunlight, the dust particles heat the air but cool the ocean surface. They also encourage cloud formation, which reinforces the reflection of light back into space. Such effects can be far-reaching: hurricanes in the Caribbean begin their life off north west Africa, with atmospheric dust being one of many factors influencing their early development” (Source: *Dust storms in Sahara Desert*). A single dust storm that occurs in both the right place and at the right time can worsen and even create a hurricane.

Clouds and Well-being

Meteorologists believe that cloud cover reduces solar radiation, which may also have effects on our feeling of well-being. When the brightness level of sunrays is increased by constriction changes in the eye pupil, the autonomic nervous system is affected. “According to Persinger (1980), increased brightness raises the rate of physical activity and leads to a general feeling of well-being. Wolfe (1981) notes that the sun’s rays cause chemical changes in neurotransmitters, or hormone synthesis in the brain. These actions perhaps stimulate production of the hormone epinephrine, and epinephrine stimulates the mind and body. Conversely, very low light intensities are often associated with states of relaxation, tiredness, and sleepiness” (Source: Kalkstein & Valimont).

LIDAR Measures Dust Clouds: Example

“The rapid movement of the air and the presence of a temperature inversion acts like a lid and ensures that a dust cloud cannot escape upwards or sideways. Weather balloons and a LIDAR remote sensing system in Leipzig produced data that showed how dust clouds can be trapped. The dust cloud was swept to Germany as if through a pipe at speeds of up to 70 kilometers per hour, and was even detected in Britain. At the end of the day, a combination of dry, vulnerable soil, strong gusts of wind, and fast transport within a dry, stable boundary layer contributed to this freak dust event in Central Europe” (Source: *Farmland dust cloud from Ukraine*).

Asthma and Air Pollution

Md. Zahidur Rahman
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

The objective of this project is to make fundamental mathematics calculations – operations on natural numbers, fractions, decimals, percentages, exponents – using the information in the attached resources in order to understand the connection between incidents of asthma and air pollution in New York State.

Math Topics
Fractions, percentages, decimals, conversion from one form to another, rounding

Purpose
Review, synthesis

Comments
Exercises are based on asthma/air pollution data

When to Introduce
Week 7

Activity Time Frame
Two weeks

Reflection

This project on asthma and air pollution demonstrates the value of numerical analysis in discussions of real-world problems. It reviews and reinforces some basic topics in arithmetic. It also requires specific topical reading. In my class, students first had a chance to carefully read the materials and had an opportunity to ask questions in the class about what was not clear to them. This approach facilitated excellent interaction in class, which contributed to students' growing awareness about environmental issues.

My personal communication with some students gave me the impression that they enjoyed the class. They liked learning about how automotive emissions play a role in triggering asthma attacks, increasing the rate of impaired lung function and other health issues. Students also said that they would like to see more such issues incorporated in mathematics teaching. For this reason, many of these students expressed a strong interest in registering for MAT096 PQL sections.

Activity Overview

Week 1:

- Discussion of asthma and its relation to air pollution from the reading (30 minutes class time).
- Consideration of quantitative requirements and support/review of fractions, decimals, and percentages (one class period).

Week 2:

- Students work out solutions to posed mathematical problems in class with instructor participation (45 minutes class time).
- Discussion of required reflection (15 minutes at the end).

Materials and Resources

- Handout
- Reading #1: Environmental Defense Fund. (2008, October 30). *Asthma, traffic and air pollution*. Retrieved February 4, 2009, from http://www.edf.org/page.cfm?tagID=38
- Reading #2: Environmental Defense Fund. (2008, October 30). *Rising disease and traffic in New York City*. Retrieved February 4, 2009, from http://www.edf.org/page.cfm?tagID=1241
- Optional links for further exploration:
  California Environmental Protection Agency. (2006, March 13). *Asthma and air pollution*. Retrieved February 4, 2009, from http://www.arb.ca.gov/research/asthma/asthma.htm

  New York City Department of Health and Mental Hygiene Childhood Asthma Initiative. (2003, May). *Asthma facts.* Retrieved February 4, 2009, from http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf

Handout: Asthma and Air Pollution

Rahman | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Read the attached materials, and then respond to Parts 1–3.

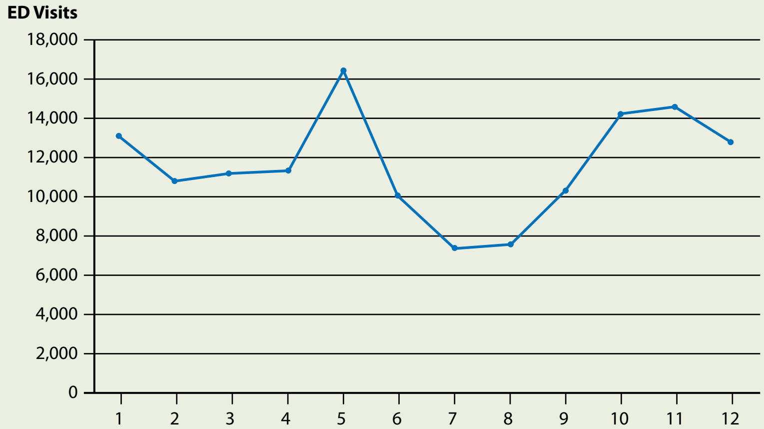
Part 1

1. What is asthma and who is affected by it?
2. What are the most important causes of asthma?
3. If 8 million people live in New York City, find the ratio of:
   a. Number of children in NYC diagnosed with asthma to total population of NYC.
   b. Number of adults in NYC diagnosed with asthma to the total population of NYC.
   c. Total number of people in NYC diagnosed with asthma to the total population of NYC.
4. Suppose that the doubling time for asthma is 15 years and that this will remain constant in the foreseeable future. Assuming that 22 million people are currently (in 2008) suffering from asthma, how many people will suffer from asthma in 2038? In 2068?
5. Suppose that 750,000 children under the age of four had asthma in 1980. According to the article, how many children under four had asthma in 1996?
6. According to the article, the economic burden of asthma was estimated to be 14 billion dollars in 2002. If a similar estimate put the cost of asthma at 18 billion in 2006, find the percentage increase in the cost of the disease.
7. According to the article, the number of vehicles entering the New York City Central Business District (CBD) increases by 7% a year and in 25 years will have reached one million vehicles. 7% annual growth means that each year the number of vehicles increases over the number in the previous year by a multiplicative factor of 1.07. Now answer this question: if the number of vehicles entering the CBD is going to be one million twenty five years from now, approximately how many vehicles enter the CBD today?

Part 2

The following activity consists of a graph and a pie chart for Asthma Emergency Department (ED), depicting visits by month and age group respectively for New York State in 2005.

Figure 1. Asthma Emergency Department (ED) Visits by Month, New York State, 2005

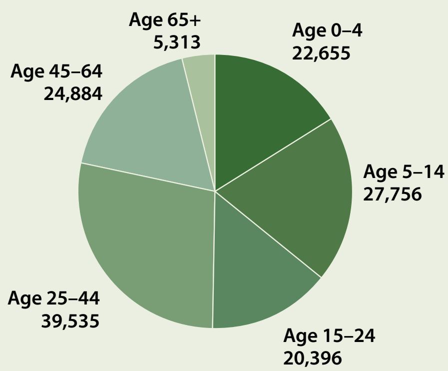


This graph was taken from the New York State Asthma Surveillance Summary report for October 2007. There were 140,539 ED visits due to asthma (that did not result in a hospitalization) for NYS residents in 2005.

1. ED visits in the worst two months constitute approximately what percentage of the total number of ED visits?
2. In the worst month for ED visits, find the average daily number of ED visits.
3. ED visits in the best two months are approximately what percentage of the total number of ED visits?
4. In the best two months for ED visits, calculate the average daily number of ER visits.

This pie chart was taken from the New York State Asthma Surveillance Summary report, October

Figure 2. Asthma Emergency Department (ED) Visits by age group, New York State, 2005



2007, page 66. The chart shows Asthma Emergency Department Visits by age group for New York State in 2005. There were 140,539 ED visits due to asthma for NYS residents in 2005. In 2005, 50,411 ED visits were for children aged 0–14 years and 5,313 ED visits were for the 65 and older age group. Among New Yorkers, the asthma ED visit rate decreased in older age groups.

Answer the following questions based on the pie chart (Figure 2):

1. Find the fraction of total ED visits for each age group.
2. Find the percentage of total ED visits for each age group.
3. Change percentage calculated for each group in question #2 to decimals.
4. Round the decimals found in question #3 to the nearest thousandth.

Part 3

Reflection: Write a one-page reflection on how the quantitative calculations that you made on asthma data enhanced your understanding of the seriousness of this epidemic for all urban dwellers.

Optional Links for further exploration:

- California Environmental Protection Agency. (2006, March 13). *Asthma and air pollution*. Retrieved February 4, 2009, from http://www.arb.ca.gov/research/asthma/asthma.htm
- New York City Department of Health and Mental Hygiene Childhood Asthma Initiative. (2003, May). *Asthma facts*. Retrieved February 4, 2009, from http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf
- Environmental Defense Fund. (2008, October 30). *Asthma, traffic and air pollution*. Retrieved February 4, 2009, from http://www.edf.org/page.cfm?tagID=38
- Environmental Defense Fund. (2008, October 30). *Rising disease and traffic in New York City*. Retrieved February 4, 2009, from http://www.edf.org/page.cfm?tagID=1241
- New York State Department of Health. (2007, October). *New York State asthma surveillance summary report.* Retrieved February 13, 2009, from www.health.state.ny.us/statistics/ny_asthma/pdf/2007_asthma_surveillance_summary_report.pdf

Reading #1: Asthma, Traffic and Air Pollution

Rahman | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Source: Environmental Defense Fund. (2008, October 30). *Asthma, traffic and air pollution*. Retrieved February 4, 2009, from http://www.edf.org/page.cfm?tagID=38

Asthma is the nation's fastest-growing chronic disease, afflicting more than 22 million Americans. Asthma rates among children under age four more than doubled over the last twenty years. Particularly hard-hit are communities of color. A recent study revealed that one-quarter of children in New York City's Harlem have asthma.

Diesel emissions have been associated with asthma and its symptoms. In traffic-choked New York City, asthma statistics are staggering. New York City's children were twice as likely to be hospitalized for asthma as the average American child. (More on rising rates of disease and traffic in New York and elsewhere).

For asthma, genetics loads the gun, but environment pulls the trigger. Once a person develops asthma, factors like dirty air can trigger an attack. Cutting traffic congestion and air pollution is one way to lessen the impact of asthma and other respiratory diseases. (For answers to common questions about traffic and health, read a Q&A with Dr. John Balbus, our chief health scientist.)

What is asthma, and who Gets It?

* Asthma is a serious chronic lung disease that inflames and constricts the airways, causing attacks of wheezing and gasping in those afflicted.
* Children (because of their body size and developing lungs) and the elderly are the most vulnerable to pollutants that trigger asthma attacks.
* Most people who develop asthma likely have a genetic predisposition to get the disease and experience critical environmental exposures during their first years of life.

What is the connection between asthma and dirty air?

* Smog and soot worsen asthma and trigger attacks. There is some evidence that ozone (a main ingredient in smog) and diesel exhaust particles may even cause asthma in some cases.
* Other triggers for asthma attacks include nitrogen oxides, formaldehyde and environmental tobacco smoke, and biological agents such as respiratory infections and allergens. Other toxic air contaminants like pesticides are suspected of contributing to asthma attacks but have not been conclusively proven to do so.
* Nearly two-thirds of those suffering from asthma live in an area where at least one federal air-quality standard is not being met.

How bad Is the asthma epidemic?

* Asthma is the nation's fastest-growing chronic disease and afflicts more than 22 million Americans.
* Asthma rates among children under age four have skyrocketed 160% between 1980 and 1996.
* The number of Americans with asthma has more than doubled in the past 15 years.

What are the costs of asthma?

* Every year, asthma is responsible for 9 million visits to health care professionals. In 2000, more than 1.8 million emergency room visits (including 728,000 visits for children under 17) and more than 460,000 hospitalizations were attributed to asthma attacks.
* More than 4,000 people lose their lives each year from this disease (with African-American children five times more likely to die than Caucasians).
* The economic burden of asthma has been estimated at $14 billion in 2002.
* Asthma is one of the leading causes of school absenteeism, accounting for over 14 million missed school days annually.
* Families with an asthma-afflicted member suffer a severe emotional toll, through lost sleep, disrupted routines and restricted activities. Many families may also suffer undue financial burden with high medical bills.

How the 1996 Olympics helped reduce asthma attacks in Atlanta

A strong case for the importance of ozone in triggering summertime asthma attacks comes from a study of Atlanta during the 1996 Summer Olympics. To reduce traffic congestion downtown during the 17 days the games were being held, the city enhanced public transit, closed downtown to private cars and encouraged businesses to promote telecommuting and alternative work hours. The study found that daily peak ozone levels dropped 28% and hospitalizations for asthma fell by almost 20% during that time.

The Atlanta case demonstrates a link between air quality and the prevalence of asthma attacks, and offers evidence that reducing air pollution is a powerful means of combating this medical scourge.

What Environmental Defense is doing

Our team of health and air pollution experts is leading the fight to clean up unhealthy pollution from tailpipes and smokestacks. Nationally, our team is working to get tight national emission standards for all diesel engines, including ships, locomotives and small engines like those on lawn mowers.

We work to ensure that Clean Air standards are implemented and enforced, from our national parks to congested cities. We push for cleaner transportation choices and better stewardship of highway projects.

Reading #2: Rising Disease and Traffic in New York City

Rahman | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Source: Environmental Defense Fund. (2008, October 30). *Rising disease and traffic in New York City*. Retrieved February 4, 2009, from http://www.edf.org/page.cfm?tagID=1241

Traffic-congested New York City has staggering rates of asthma and higher cancer risk

As a first step toward understanding the potential threat in New York City, Environmental Defense Fund mapped a simple 500-foot risk zone around the city's most congested streets (see "Who's at Risk in New York?"). The second step was to look at the city's disease rates and risks, which underscore the impact of traffic-related pollutants.

The lifetime cancer risk due to diesel exhaust in both Bronx County and Queens County is over 900 times the acceptable EPA standard, while New York County's risk is over 3000 times that limit. Vehicle emissions contribute over 80 percent of the total cancer risk from hazardous air pollutants in New York City.

Staggering rates of asthma

Diesel emissions have been associated with asthma and its symptoms. New York's asthma statistics are staggering: An astounding 300,000 children and 700,000 adults living in New York City have been diagnosed with asthma. In 2000, New York City's children were twice as likely to be hospitalized for asthma as the average American child.

Since people with asthma are much more sensitive to air pollutants than people with healthy lungs, this means there are roughly a million New Yorkers who need special protection from noxious air.

Rising traffic levels in New York

Minimizing these health problems requires a two-pronged solution: managing traffic growth rates and cleaning up dirty vehicles. On the plus side, New Yorkers have relatively low rates of car ownership and benefit from an extensive public transportation system.

But because Manhattan is the only county in the country with more jobs than residents, many of those workers drive from or through the other boroughs, exacerbating existing traffic snarls throughout the city.

Since the 1920s, vehicle travel into Manhattan south of 60th Street (the Central Business District or CBD) has increased by an average of seven percent annually. If that trend continued for the next 25 years, it would mean one million vehicles per day entering the CBD. Given the already high level of congestion, that volume of traffic would be untenable.

Even under scenarios that include traffic management improvements:

* In the Bronx, vehicle miles traveled are expected to increase by almost ten percent, to ten million miles per day.
* In Queens, the average speed will drop to 13.8 miles per hour.

Currently, drivers in the New York region spend more than the equivalent of a full work week each year stuck in traffic. These increases in traffic and congestion require multifaceted actions to provide a healthy and livable New York for the 21st century.

The Diaper Debate

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Project Quantum Leap

Objectives

This assignment asks students to read two articles with contrasting views about whether using disposable diapers or cloth diapers is better for the environment. Students will apply their mathematical skills to analyze the numerical information presented in these two articles. By using the "diaper debate" as a way to learn math, students will see how the mathematical concepts they are learning relate to the world. Students will also be engaged with issues that are familiar from their own experience. By examining the math found in the articles, students will learn about percentages, ratios, and measurements. Some of the problems the students will solve in class will be COMPASS-type problems. They will also learn how to write a paragraph that expresses their opinion based on math.

Math Topics
Percentages, ratios, proportions

Purpose
Motivation

When to Introduce
Week 7

Activity Time Frame
Two weeks

Reflection

In the past half-century, parents in the U.S. have shifted from using cloth diapers to using disposable ones. The impact of this choice on the environment has been immense, and often overlooked. By reading about this issue and learning how to make certain calculations, I hoped that students would become aware of the surprising size of the problem and, at the same time, learn about percentages, ratios, measurements, and decimals. Diaper-related topics are also inherently humorous, which I thought would help to keep the students interested.

Students often find the techniques they learn in class overly abstract and, thus they think of math as something that simply needs to be memorized. Subsequently, they often find it difficult to know when and how to apply mathematical methods to real-life choices. By setting up this assignment through a real issue that affects every household with children, I hoped that this barrier would be diminished, and that students would find themselves more motivated to learn.

I was pleased to find that, indeed, the students were excited to explore the issue. Many of them were surprised to learn that using cloth diapers could also be detrimental to the environment. I was thus able to direct their interest towards examining how this could be the case. In doing so we explored percentages, ratios, and other concepts. The readings helped the students understand that the problems presented to them were significant and needed to be wrestled with.

Many of the students in my class were themselves parents and were interested in trying to figure out which kind of diaper was actually better to use. And though a final answer remains elusive, trying to answer the question through mathematical topics was a great experience for them.

Activity Overview

During the first class of the implementing week, I assigned the readings as homework. The readings describe recent research that suggests that cloth diapers may be just as bad for the environment as disposable diapers. It had previously been thought that disposable diapers had a much worse environmental impact because of the huge amount of waste they create each year. The new research suggests that the extra water it takes to wash cloth diapers is approximately equivalent – in terms of environmental impact – to the landfill problems disposables create. The articles mention criticism of the new research and many viewpoints from both sides of the debate.

Agenda for the second class:

1. I gave the students a list of facts about disposable diapers vs. cloth diapers (Handout #2). These facts were based on the articles.
2. I then led a short discussion about the topic to explore what they had learned and heighten their interest.
3. Next, I explained some of the math concepts that could be found in the articles: percentages, proportions, and ratios.
4. I demonstrated how to derive some of the percentages found in the fact sheet.
5. I assigned similar problems for homework, using numbers found on the fact sheets.

Here is a sample of some of the questions discussed:

- In Seattle, disposable diapers have increased from 2.5 percent of all residential waste in landfills in 1988 to 3.3 percent in 1994, according to the Residential Waste Stream Composition Study by the Cascadia Consulting Group. By what percentage did it increase?
- On average, parents spend around $1500 for disposable diapers for a single child. In contrast, parents who use cloth diapers spend around $430.80. What is the ratio of the cost of cloth diapers to the cost of disposables?
- According to one study, 78% of babies in disposable diapers get diaper-rash, compared to only 7% of cloth-diapered babies. Among 10,000 babies, assume 95% wear disposable and 5% wear cloth diapers. Estimate how many babies might have diaper-rash.

In a subsequent class we reviewed the material and I asked students to write a short reflection about the activity.

Materials and Resources

- Handout
- Reading #1: Onion, A. (2005, May 26). The diaper debate: *Are disposables as green as cloth? ABCNews.com*. Retrieved February 4, 2009, from http://abcnews.go.com/Technology/Story?id=789465&page=1
- Reading #2: Caldwell, Ginny Caldwell. (n.d.) Cloth vs. disposable diapers. *Ecomall: A place to help save the earth*. Retrieved February 4, 2009, from http://www.ecomall.com/greenshopping/diaper2z.htm
- The Peace and Environment Resource Centre. (n.d.) *The ecological debate: cloth vs. disposable*. Retrieved February 4, 2009, from http://www.perc.ca/waste-line/articles/diaper.html

Handout: The Diaper Debate

Yuan | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

As you will learn from reading the articles by Amanda Onion (http://abcnews.go.com/Technology/Story?id=789465&page=1) and Ginny Caldwell (http://www.ecomall.com/greenshopping/diaper2z.htm):

- "Although there are no recent estimates on the number of U.S. parents who choose disposable or cloth diapers, studies from the 1990s found that about 95 percent of American parents choose disposable diapers over reusable ones" (Onion, 2005).
- The Union of Concerned Scientists has estimated that about 18 billion diapers are thrown into landfills every year (see Onion).
- A 1998 study by the Environmental Protection Agency found that diapers made up 3.4 million tons of waste, or 2.1 percent of U.S. garbage in landfills that year (see Onion).
- In terms of environmental impact, two and a half years of diaper waste from one child is roughly comparable to driving a car between 1,300 and 2,200 miles (see Onion).
- In 1990, 18 billion disposable diapers were thrown into United States landfills. It takes 3.4 billion gallons of oil and over 250,000 trees a year to manufacture that many diapers (see Caldwell).
- According to the Journal of Pediatrics, 54% of one-month-old babies using disposable diapers had rashes, 16% had severe rashes (see Caldwell).
- A survey of Procter & Gamble's own studies show that the incidence of diaper rash increases from 7.1 percent to 61 percent with the increased use of throwaway diapers (see Caldwell).

Please read both the assigned articles and review the points summarized above. Then answer the following questions:

Question 1: How many diapers can a single tree produce?

Question 2: On average, children in the U.S. wear diapers until they are 30 months old. If this average is reduced to 20 months, how many fewer diapers will a single child save? Assume that a child wears an average of 8 diapers a day.

Question 3: Assume that among the 2 million children in the U.S., the average diaper-wearing time will be reduced from 30 months to 20 months. How many trees will this reduction save?

Question 4: "In Seattle, disposable diapers increased from 2.5 percent of all residential waste in landfills in 1988 to 3.3 percent in 1994, according to the Residential Waste Stream Composition Study by the Cascadia Consulting Group." By what percentage did it increase?

Question 5: Based on a variety of sources (see References) , we assume that parents spend around \$1500 for disposable diapers for a single child. In contrast, parents who use cloth diapers spend around \$330. What is the ratio of the cost of cloth diapers to the cost of disposables?

Question 6: According to one study, 78% of babies in disposable diapers get diaper rash, compared to only 7% of cloth-diapered babies. Among 10,000 babies, assume 95% wear disposable and 5% wear cloth diapers. Estimate how many babies might have diaper rash.

Question 7: To obtain the percentage of U.S. waste made up of disposable diapers, begin with the assumption that the average American generates 1,000 pounds of waste each year. This is equivalent to 112 million tons of waste from households and commercial sources. Assuming that the average used diaper weighs about half a pound when thrown away and approximately 18 billion diapers are thrown away each year, what percentage of the total U.S. household waste is composed of single-use diapers?

Question 8: Ask one of your family members, or one of your friends who has young children, how many diapers he or she uses. Compare with the national average.

Reflection

The debate over which type of diaper is "greener," or better for the environment, continues. Write a paragraph about what you have learned regarding this topic. Should we use disposable diapers or cloth diapers? What did you learn from your reading? How has the reading changed your view about the issue? What facts surprised you the most?

Guidelines for writing your paragraph:

- First state what your opinion was before you read the articles.
- Then state your opinion after you read the articles.
- Explain the reason why your opinion changed or remained the same.

Deposit your writing in your ePortfolio.

Reading #1: Are Disposables as Green as Cloth?

Yuan | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Source: Onion, A. (2005, May 26). *The diaper debate: Are disposables as green as cloth?* Retrieved February 4, 2009, from http://abcnews.go.com/Technology/Story?id=789465&page=1

New British Study Adds to Conflicting Conclusions on the Greenest Way to Diaper Your Baby's Bottom

Shoppers may face the "paper or plastic" dilemma in checkout lines, but for most parents, choosing between diapering their babies in disposables or cloth diapers has become less of a dilemma and more of a foregone conclusion.

"Disposable diapers are so widely used the phrase has practically become redundant," said Mark Stief, owner of the Baby Diaper Service in Seattle.

A new study released in England by a quasi-government environmental organization may dampen the debate even further. After a three-year, 200,000-pound (about $360,000) study, the London-based Environmental Agency concluded that disposable diapers have the same environmental impact as reusable diapers when the effect of laundering cloth diapers is taken into account.

"Although there is no substantial difference between the environmental impacts of the three systems studied, it does show where each system can be improved," said Tricia Henton, director of environmental protection at the Environment Agency.

Reusable diaper advocates in this country, however, claim the study is seriously flawed and stands to only confuse parents about the consequences of how they diaper their children.

"If you're trying to reduce your environmental impact, you can do that significantly by using cloth diapers," said Lori Taylor, a Buffalo, N.Y., mother and co-founder of the non-profit Real Diaper Association. "It's all in the way you wash them, how many you have and the kind of reusable diaper you use."

From Babies' Bottoms to Landfills

Although there are no recent estimates on the number of U.S. parents who choose disposable or cloth diapers, studies from the 1990s found that about 95 percent of American parents choose disposable diapers over reusable ones. Some, including Stief, believe the number of disposable diaper-using parents has increased even more as the demand for diaper services across the country has declined, along with the corresponding number of available diaper services.

All those dirty diapers amount to a growing mound of waste. The Union of Concerned Scientists has estimated about 18 billion diapers are thrown into landfills every year. And a 1998 study by the Environmental Protection Agency found that diapers made up 3.4 million tons of waste, or 2.1 percent of U.S. garbage in landfills that year.

Even "green" disposable diaper brands, such as Seventh Generation and Nature Boy and Girl, which contain more biodegradable materials, can sit for years in landfills. Research by Bill Rathje, a trash expert and professor emeritus at the University of Arizona, has shown that even a head of lettuce, let alone a plastic diaper, can persist for decades in a landfill where there is often a lack of exposure to air and sun that would otherwise break materials down.

As the British study points out, however, no dirty diaper (or "nappy," as they're known in the U.K.) is impact-free. The water and energy required to wash and dry cloth diapers also take their toll, particularly as energy resources become strained.

"The most significant environmental impacts for all three nappy systems were on resource depletion, acidification and global warming," the authors concluded. "For one child, over two-and-a-half years, these impacts are roughly comparable with driving a car between 1,300 and 2,200 miles."

Representatives at Proctor & Gamble, the largest manufacturer of disposable diapers, including Pampers, which was first introduced in 1961, were pleased with the British report's findings.

The results, said P&G spokeswoman Lisa Hulse Jester, "confirm that what we first learned over a decade ago – that neither disposable nor cloth diapers are better or worse for the environment."

Flawed Findings?

As Jester points out, the British report's findings parallel those from a study released in this country more than a decade ago. That research conducted by Arthur D. Little, Inc. and commissioned by P&G concluded that laundering a cloth diaper over the course of its lifetime consumes up to six times the water used to manufacture a single-use diaper. That water consumption, the authors said, is comparable in impact to the waste produced by disposables.

But critics say both the current study and the one commissioned by the diaper company in 1990 were flawed in ways that favor disposables.

The Women's Environmental Network, a London-based environmental group, points out that the current British report surveyed 2,000 parents who use disposables, but included only 117 parents who use cloth diapers in their research.

Furthermore, the study focused on terry-cloth diapers, which take more water to wash and more energy to dry. Finally, WEN says that the study also assumes parents are not using energy-efficient washer/dryers and that they're washing clothes at a high temperature setting.

"If parents use 24 nappies and follow manufacturers' instructions to wash at 60 degrees C [140 degrees Fahrenheit] using an A-rated washing machine, they will have approximately 24 percent less impact on global warming than the report says," said WEN's Ann Link.

Using a diaper service means consuming even less water and energy. Stief says that his company washes three days worth of a customer's diapers with the amount of water used in a single toilet flush. His Seattle company is also looking into purchasing vehicles that run on eco-friendly fuels to lessen the impact of picking up and dropping off the diapers.

But for most Americans, there is no local diaper service available. In fact, some argue the 1990 Little study encouraged more parents to use disposables and contributed to a dramatic decline in the use of diaper services throughout the 1990s. Today, the National Association of Diaper Services estimates there is at least one diaper service in 42 of the 50 states.

Is One Better for Health, Potty Training?

Whatever the best choice may be when it comes to minimizing the environmental impact of diapers, Taylor argues there may also health factors to consider. A 2000 German study concluded that boys who wear disposable diapers maintain a higher scrotal temperature than boys wearing cloth diapers, which may pose fertility issues later in life.

Another study published in 1999 by Anderson Laboratories found that lab mice exposed to various brands of disposable diapers experienced asthma-like symptoms, as well as eye, nose and throat irritation. Exposure to cloth diapers did not cause the symptoms.

Finally, toilet training experts, including Narmin Parpia, a Houston-based mother who offers toilet training advice online, have suggested that disposable diapers may postpone how soon a child learns to abandon the diaper for the toilet.

"Children don't feel the wetness in these disposable diapers, so they don't realize what's happening when they go," Parpia said. "When cloth is used, they feel wet and uncomfortable, which may help them learn sooner."

But when faced with such an onslaught of conflicting advice and study results it can be difficult to know what to believe. Even choosing between the myriad of diaper styles now available can be daunting. In recent years, a number of mostly small, largely online-based companies have started selling a variety reusable diaper brands. Among the available models parents can now choose from are traditional, flat diapers, pre-folded diapers, fitted diapers, diapers with snap covers, Velcro covers and no covers – even diapers with patterns and colors.

For those who may be confused about the best route – and diaper – to choose, one parent, K. Moore of Southhampton, England, offered her advice in a recent letter to the London Times.

"The difficulties of raising a baby are enough without the added pressure of being told you are environmentally unfriendly," she wrote. "We just have to pick and choose when and where to do our bit."

Reading #2: Cloth vs. Disposable Diapers

Yuan | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Source: Caldwell, Ginny Caldwell. (n.d.) Cloth vs. Disposable Diapers. *Ecomall: A place to help save the earth*. Retrieved February 4, 2009, from http://www.ecomall.com/greenshopping/diaper2z.htm

Dyes found in some disposables are known to damage the central nervous system, kidneys, and liver. The Food & Drug Administration (FDA) received reports that fragrances caused headaches, dizziness, and rashes. Problems reported to the Consumer Protection Agency include chemical burns, noxious chemical and insecticide odors, reports of babies pulling disposables apart and putting pieces of plastic into their noses and mouth, choking on tab papers and linings, plastic melting onto the skin, and ink staining the skin. Plastic tabs can also tear skin, and disposables may contain wood splinters.

In 1987, the Sunday Democrat and Chronicle published news about the new Pampers Ultra. The new gel they used caused severe skin irritations, oozing blood from perineum and scrotal tissues, fever, vomiting, and staph infections in babies. Employees in Pampers factories suffered from tiredness, female organ problems, slow-healing wounds and weight loss. According to the Journal of Pediatrics, 54% of one-month old babies using disposable diapers had rashes, 16% had severe rashes. A survey of Procter & Gamble's own studies show that the incidence of diaper rash increases from 7.1 percent to 61 percent with the increased use of throwaway diapers, great for manufacturers of diaper rash medicines. Widespread diaper rash is a fairly new phenomenon that surfaced along with disposable diapers. Reasons for more rashes include allergies to chemicals, lack of air, higher temperatures because plastic retains body heat, and babies are probably changed less often because they feel dry when wet.

Disposables and Public Health & Landfill Concerns

About 5 million tons of untreated body excrement, which may carry over 100 intestinal viruses, is brought to landfills via disposables. This may contribute to groundwater contamination and attract insects that carry and transmit diseases. In 1990, 18 billion disposables were thrown into United States landfills. Is it wise to use 3.4 billion gallons of oil and over 250,000 trees a year to manufacture disposables that end up in our already overburdened landfills? These disposables are not readily biodegradable. The paper must be exposed to air and sun to decompose. Thirty percent of a disposable diaper is plastic and is not compostable. Even if the rest of the diaper could be composted, these plants could only handle 400 of the 10,000 tons of diapers tossed in landfills EACH DAY, assuming they didn't have to process any other compostable garbage. Biodegradable diapers have cornstarch added to the plastic to break it into tiny pieces. The pieces still end up in landfills.

Inaccurate and Misleading Information from Disposables Manufacturers

It's the late 1980's, people are becoming concerned about the environment. Disposables are on the decline. The disposables manufacturers fight back. Articles and advertisements say disposables are OK. Many mothers, glad to hear that and relieved of guilt, switch to disposables. Disposables manufacturers say energy usage is the same for cloth or disposables, but the fact is that throwaways use five times more energy than reusables.

Cloth Diapers Are Easy, Simple, Inexpensive

Diapers do not need to be presoaked, I don't even rinse mine. Just dump solids in toilet, if it does not fall out then put in hamper, the washing machine will do the rest. No pins are necessary. Two loads of laundry a week.

You have a lot of options available through several mail order companies. There are diaper and cover combinations or All-in-one diapers which are as easy as disposables. The representatives at these companies can assist in your choice. The total cost runs from $200–$300 to get started but will take you through the first year or so.

The Tragedy of Tar Creek

Dmitriy Chebanov
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Math Topics
Rates, ratios, decimals, and proportions

Purpose
Synthesis

When to Introduce
Week 7 (or when the topic "Problems with Decimals" has been covered)

Activity Time Frame
Three lessons: assign reading on the first day, solve problems in class on the next, and collect the homework assignment on the final day.

Objectives

This activity is designed to strengthen students' ability to compute rates and ratios and solve proportions with decimals. Students will extract data from readings in two different contexts and apply their problem solving skills to the quantitative analysis of this data.

Reflection

Developed as a supplement to regular coursework, this activity contextualizes problems with decimals.

Each problem consists of a reading and a set of questions. The first reading, a portrait of the world's fastest humans, serves as a motivator and a trial run for the second reading, which focuses on the environmental disaster at Tar Creek and many other poisoned wastelands Americans deal with every day.

After reading each story, students are asked to work with numerical data, using the same mathematical tools to answer a set of related questions. For most students, finding the necessary data in the text is usually the most challenging component of the activity. This, therefore, requires special attention from the instructor. Once the data is extracted successfully from the text, students usually feel comfortable completing the rest of the assignment. This activity will encourage students to learn to read critically and use the tools of basic mathematics to analyze the information they are exposed to during the course of everyday life.

Activity Overview

This activity should be implemented in the course of three scaffolded lessons that offer students the opportunity to apply the mathematical knowledge and skills they learned in class. During the first lesson, the instructor introduces the activity and assigns Reading #1, "The World's Fastest Human," for homework. A portion of the second lesson (about 30 minutes) is spent discussing this article and answering the follow-up questions on Handout #1. The instructor should guide the students as they work on the questions.

For the second part of the activity, students read the second article, "The Tragedy of Tar Creek," and then do the exercises on Handout #2. It is best to assign this part of the activity for homework. Students are asked to submit a written report containing their answers to the questions listed in Handout #2 and their reflections on the reading material.

During the third lesson, students report on their work and reflect on their experience.

Materials and Resources

- Handout #1: Chart of Sprinters' Achievements and Questions
- Reading #1: Altman, A. (2009, August 18). The world's fastest human. *TIME*. Retrieved January 14, 2011, from http://www.time.com/time/arts/article/0,8599,1917099,00.html
- Handout#2: Charts of Superfund Sites and Questions
- Reading #2: Roosevelt, M. (2004, April 26). The tragedy of Tar Creek. *TIME*. Retrieved January 14, 2011, from http://www.time.com/time/magazine/article/0,9171,993911,00.html

Handout #1

Chebanov | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

First, read the article, "The World's Fastest Human," a story by Alex Altman. Then, consult the following chart containing the names of world-renowned sprinters along with some of their achievements.

Chart of sprinters' achievements

Name	Achievements
Usain Bolt	The Jamaican sprinter also owns the 200-m mark: 19.30 sec.
Charley Paddock	A 100-m gold medalist at the 1920 Olympics
Ben Johnson	He ran the 100-m in 9.79 seconds at the 1988 Olympics in Seoul.
Carl Lewis	A nine-time gold medalist, he set a 100-m world record by running a 9.86 in 1991.
Michael Johnson	The gold-shoed speedster ran a scorching 19.32 in the 200-m dash in 1996, spurring some to tout him as the world's fastest human.

Using both the reading and the chart, answer the following questions:

1. What was Usain Bolt's average speed when he ran the 100-m dash in Berlin?
2. If he maintained this speed during the 400-m race, how long would it take him to finish?
3. In which race did he run faster: the 100-m dash in Berlin or when he set his 200-m world record?
4. Put the sprinters listed in the chart in ascending order: from the slowest [top] to the fastest [bottom].
5. In the 100-m race, how much faster was Usain Bolt in 2009 than Charley Paddock in 1921?

Reading #1: The World's Fastest Human

Chebanov | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Source: Altman, A. (2009, August 18). The world's fastest human. *TIME*. Retrieved January 14, 2011, from http://www.time.com/time/arts/article/0,8599,1917099,00.html

The World's Fastest Human

By ALEX ALTMAN Tuesday, Aug. 18, 2009

Jamaica's Usain Bolt celebrates winning the 100-m final at the 12th IAAF World Championships in Athletics, Berlin

He shocked everyone but himself. Less than a year after blazing into history by setting a world record in the 100-m dash at the Beijing Olympics, Usain Bolt broke his own mark on Aug. 16 in Berlin. At the same site where American Jesse Owens upstaged Adolf Hitler 73 years ago, Bolt shaved more than a tenth of a second off his own record, clocking an absurd 9.58 seconds. Never shy about touting his talent, Bolt hinted at even greater successes ahead. "I think it will stop at 9.4, but you never know," he said. At this point, nothing seems impossible for the lanky, 22-year-old Jamaican, whose win cemented his place in track-and-field lore, and left no doubt that he owns the sport's most fabled title: World's Fastest Human.

Only 17 men have staked claim to the honor, which has grown in stature since Donald Lippincott became the first official world-record holder in the 100-m dash at the 1912 Stockholm Olympics. Lippincott, a student at the University of Pennsylvania, was an unlikely winner: a supplementary member of the U.S. Olympic team, he was allowed to compete in the event only after he agreed to pay his own way to Sweden. After shocking observers by running a 10.6 in a preliminary heat, Lippincott fizzled in the final, finishing third. Still, his mark stood until his compatriot, Charley Paddock, topped him by notching a 10.4 at a meet in California nine years later. The reigning Olympic champion, Paddock won attention as much for his prerace habits as for his speed; the colorful sprinter was renowned for quaffing a sherry mixed with raw egg before entering the blocks. (Read about Bolt's record-breaking performance in Beijing.)

In 1930, Percy Williams, a Canadian, became the first non-American to take the title. Six years later, Owens took the record back with a 10.2-second time — part of the epic performance in Berlin in which the sprinter notched four gold medals and punctured Hitler's vision of Aryan supremacy beneath the Fuhrer's scornful gaze.

Owens, who famously said the secret to his success was to "let my feet spend as little time on the ground as possible," helped usher in a fleet of impossibly swift African-American sprinters. Among then was Bob (Bullet) Hayes, who won the gold medal in the 100-m sprint at the 1964 Olympics in Tokyo and recorded what some observers consider the top time ever achieved by a human with an 8.6 split in the 4 x 100-m relay. (Relay marks are faster than regular sprints because runners receive the baton while in motion, enabling them to accelerate quicker.) Hayes later parlayed his speed into a career as a wide receiver for the Dallas Cowboys; his passing in 2002 prompted one columnist to remark that Death must have tied his shoelaces together to catch him. In the 1980s and '90s, Leroy Burrell and Carl Lewis both held the World's Fastest Human title twice, and Lewis, in particular, converted the title into endorsement riches. At the Atlanta Olympics in 1996, Canadian Donovan Bailey snatched the mantle by speeding to gold in 9.84 seconds, earning himself a spot in a 150-m duel with Michael Johnson, the gold-shoed sensation who set Atlanta ablaze by running the 200-m event in a record-setting 19.32 seconds. But the race, which took place in June 1997 at the Toronto Skydome, was an unmitigated bust; fans derided the event as a corporate showcase that sullied the sport, and Johnson pulled up lame with a quadriceps injury halfway through.

It was one in a series of recent low moments for sprinting's most exclusive fraternity. "I'll tell you this: once you become that, you can only go down," Hayes told Sports Illustrated in 2001. Shaving fractions of a second off a speed at which humans aren't built to go isn't easy, and several title holders have crumbled under the pressure. In 1988, Jamaican-born Canadian Ben Johnson clocked a scorching 9.79 at the Seoul Olympics, but quickly had his record expunged after testing positive for the anabolic steroid stanozolol. Johnson wasn't the last World's Fastest Human to succumb to the lure of steroids. American sprinter Justin Gatlin, who ran a 9.77 at a meet in Qatar, is serving a four-year suspension for doping, and Tim Montgomery — who called the title the "top of the food chain" in sports — was ensnared in the BALCO steroid scandal and stripped of his record. He is currently serving time in an Alabama prison for bank fraud and heroin distribution.

Thanks to Bolt, a 6 ft. 5 in. blur known to punctuate his victories with biceps curls, track finally has the savior seemingly capable of resurrecting its fortunes. Charismatic, telegenic and steroid-free — he has passed every test administered to him and attributed his win in Beijing to a steady diet of chicken nuggets — the colorful star has outsize talent and a personality to match. "I just blew my mind and blew the world's mind," Bolt said after racing to glory last August. On Aug. 16 he did it again.

Read more: http://www.time.com/time/arts/article/0,8599,1917099,00.html#ixzz18xaUhjjn

Handout #2

Chebanov | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

The Hot Spots

Sixty-five million Americans live within four miles of a Superfund site. The top ten states

New Jersey	113	Florida	51
California	96	Washington	47
Pennsylvania	92	Texas	43
New York	90	Illinois	40
Michigan	67	Wisconsin	39

Superfund by the Numbers

Number of sites on the priority list since 1980	1,518
Number of Superfund sites listed today	1,240
Number of sites cleaned up and deleted from the list	278
Number of sites currently being cleaned up	622
Number of years, on average, it takes to decontaminate a site	11
Number of highly toxic sites eligible for listing	2,500
Decline in Superfund appropriations since 1993, adjusted for inflation	35%
Number of cleanups completed in the 2003 fiscal year under President Bush	40
Average number of annual cleanups under President Clinton	76

Using both Reading #2, "The Tragedy of Tar Creek," and the charts above, answer the following questions:

1. What is the ratio of the Superfund locations in Florida to all Superfund sites? What is the ratio of the Superfund locations in New York to all Superfund sites?
2. a) Starting from 1980, what is the average rate of cleanup per year ?
   b) On average, how much faster were Superfund sites cleaned up under President Clinton?
3. a) What is the ratio of the Superfund sites currently being cleaned up to the total number of sites that are on the list now?
   b) How would this ratio change if all eligible sites were listed?
4. a) According to the charts, how many Americans were living within four miles of a Superfund site in 2005?
   b) According to the reading, what was the ratio of Americans living within four miles of a Superfund site to the total number of Americans in 2005?
   c) Using your answers to parts (a) and (b), find the population of the United States in 2005.
5. a) How much money has been spent under the Superfund program since 1980?
   b) What fraction of this amount went towards repairing Tar Creek?

Reading #2: The Tragedy of Tar Creek

Chebanov | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Source: Roosevelt, M. (2004, April 26). The tragedy of Tar Creek. *TIME*. Retrieved January 14, 2011, from http://www.time.com/time/magazine/article/0,9171,993911,00.html

Note to students: Read the entire article, but pay special attention to the *highlighted paragraphs*.

The Tragedy Of Tar Creek

By MARGOT ROOSEVELT/PICHER, OKLA. Monday, Apr. 26, 2004

To get a better view of the situation, John Sparkman guns his flame-red truck up a massive pile of gravel. From the summit, a lifeless brown wasteland stretches to the horizon, like a scene from a science-fiction movie. Mountains of mine tailings, some as tall as 13-story buildings, others as wide as four football fields, loom over streets, homes, churches and schools. Dust, laced with lead, cadmium and other poisonous metals, blows off the man-made hills and 800 acres of dry settling ponds. “It gets in your teeth,” says Sparkman, head of a local citizens’ group. “It cakes in your ears and hair. It’s like we’ve been environmentally raped.”

Hyperbole? Drive through the desolate towns around Picher, Okla., and you might think differently. This is eco-assault on an epic scale. The prairie here in the northeast corner of the state is punctured with 480 open mine shafts and 30,000 drill holes. Little League fields have been built over an immense underground cavity that could collapse at any time. Acid mine waste flushes into drinking wells. When the water rises in Tar Creek, which runs through the site, a neon-orange scum oozes onto the roadside. Wild onions, a regional delicacy tossed into scrambled eggs, are saturated with cadmium--which may explain, local doctors say, why three different kidney dialysis centers have opened here to serve a population of only 30,000.

But the grimmest legacy of a century of intensive lead and zinc mining are the “lead heads,” or “chat rats,” as the kids who grew up around here are known. As toddlers, they played in sandboxes of chat--the powdery output of mills after ore is extracted from rock. As preteens, they rode their bikes across the gravel mounds and swam in lime-green sinkholes. Their parents used mine tailings to make driveways and foundations, never thinking that contaminated dust might blow through the heating ducts of their ranch houses. In the past decade, studies have shown that up to 38% of local children have had high levels of lead in their blood--an exposure that can cause permanent neurological damage and learning disabilities. “Our kids hit a brick wall,” says Kim Pace, principal of the Picher-Cardin Elementary School. “Their eyes skip and jump. It takes them 100 repetitions to learn a sound.”

At her kitchen table, Evona Moss helps her son Michael, 10, with his homework. Michael grew up across the street from a chat pile, and at one point the third-grader’s lead levels measured 40% above the Centers for Disease Control’s danger level. He repeated kindergarten. “I used to think he was lazy,” says his mother, “but he tries so hard. One minute he knows the words, and a half-hour later he doesn’t. Every night he kneels down and prays to be a better reader.”

It wasn’t supposed to be like this. In 1980, Congress passed the Comprehensive Environmental Response, Compensation and Liability Act--commonly known as the Superfund law--one of the boldest environmental statutes in U.S. history. It was a law designed to fit all circumstances. It covered existing plants whose owners could be forced to clean up their dumps. It covered polluted sites long since abandoned by their owners: defunct factories, refineries and mines. Even when companies followed the standard, if dubious, practices of the day--dumping toxic waste in rivers, burying it in leaky drums or just leaving it, as in Oklahoma, to blow in the wind--they would be held accountable. And if they refused to clean up their messes, the Environmental Protection Agency (EPA) would do so for them and charge treble damages for its trouble. In the event that the perpetrators had disappeared or gone out of business, a general tax on polluting industries--a “Superfund”--would pay to fix the damage.

But today Superfund is a program under siege, plagued by partisan politics, industry stonewalling and bureaucratic inertia. The U.S. government has spent $27 billion on the effort and forced individual polluters to spend an additional $21 billion. Love Canal, the deadly dump in New York State that spurred the law’s passage, has been capped with a layer *of clay, and the EPA proposed last month to take it off the list. So far, 278 sites have been delisted. But there are thousands more out there. According to the General Accounting Office (GAO), 1 out of 4 Americans still lives within four miles of a Superfund site--many of them killing fields saturated with cancer-causing chemicals and other toxins.*

The GAO reports that the program's budget fell 35% in inflation-adjusted dollars over the past decade. And environmentalists say that Bush appointees are slowing the pace of cleanups and failing to list potential new sites. According to the EPA's inspector general, 29 projects in 17 states were underfunded last year. The Administration, charges New Jersey Senator Frank Lautenberg, a Democrat, has "allowed--deliberately--these sites to rot where they are."

Tar Creek is a case in point. Two decades after it was targeted on the very first Superfund priority list, the 40-sq.-mi. site is worse off than ever. Early on, the government confined its effort to the polluted creek, without looking at chat piles, soil, air quality or the danger of subsidence. Was it a lack of knowledge of the danger, as EPA claims? Or industry influence, as environmentalists charge? Whatever the reason, federal attorneys settled with mining companies for pennies on the dollar. Now, after fruitless efforts to contain 28 billion gal. of acid mine water, contamination is spreading across a vast watershed. And although the EPA trucked out toxic dirt from about 2,000 homes and schools, Tar Creek's children still show elevated lead levels at six times the national average.

Administration officials say they are cleaning up the nation's 1,240 highest-priority sites as fast as they can. But that will be harder, since the multibillion-dollar industry-paid trust fund, set aside for abandoned sites such as Tar Creek, ran dry in October. The fund was supplied by taxes on the purchase of toxic chemicals and petroleum and on corporate profits above $2 million. But the Republican-led Congress allowed the fees to expire in 1995. Bush is the first President to oppose the levies, and last month Lautenberg and other Senate Democrats lost a narrow vote to reinstate them. In protest, the Sierra Club aired "Make Polluters Pay" TV ads in Pennsylvania, Florida and Michigan--all swing states. And on April 15, tax day, activists in 25 states picketed post offices to object. "We went from polluters paying to citizens paying," says Oklahoma environmentalist Earl Hatley. "Now EPA doesn't have the money for megasites like Tar Creek."

Meanwhile, Superfund defenders in Washington are bracing for a new battle: a Bush-appointed advisory committee, which they claim is heavily stacked with corporate members, issued a report last week that pushes for administrative changes. "It is a wonky thing," says Julie Wolk of the Public Interest Research Group. "But it could dramatically weaken the program." Companies want to limit liability and shift responsibility to the states, where rules are more flexible. Federal standards are "rigid and extreme," says Michael Steinberg of the Superfund Settlements Project, an industry group that includes General Electric, DuPont and IBM. "Groundwater must meet standards for tap water, even though at many of these sites no one drinks it. Soil at many sites must be clean enough so people could play in it. The costs exceed the benefits."

With the EPA's clout slackening, private attorneys are moving in. At Tar Creek, lawyers are suing seven mining companies on behalf of scores of lead-exposed children. A separate suit demanding a cleanup was filed by the Quapaw Indians, whose land was leased for the mines. And environmentalist Robert F. Kennedy Jr. has joined a class action to force companies to relocate the population of two polluted towns, Picher and Cardin. Court papers suggest that mining executives knew as early as the 1930s that the contaminated dust was dangerous but sought to, in their words, "dissuade" the government from intervening. A mining-company lawyer says the charge is based on "out-of-context reading" of historical documents.

Just how dangerous that dust might be is still a matter of dispute. Doctors at the Harvard School of Public Health have begun extensive studies in Tar Creek, not just of lead exposure but also of the cocktail mix of lead, manganese, cadmium and other metals that interact in unknown ways. "We're looking at four generations of poisoning," says Rebecca Jim of the L.E.A.D. agency, a local group. Meanwhile, parents like Evona Moss wonder what else the toxic brew might have done. Did it cause her obesity and bad teeth? Is it responsible for the malformation of her daughter's shins? Does her baby's asthma come from the chat? Her nephew's cancer? No one knows because no one has done careful, long-term studies.

Tar Creek is an extreme case. But like Tolstoy's unhappy families, every Superfund site is tragic and contentious in its own way. In Libby, Mont., a massive mine blanketed the town with asbestos dust, killing at least 215 people and sickening 1,100 more with cancer and lung disease--yet cleanup funds have been cut so sharply that it could take 10 to 15 years to finish the job. In Coeur d'Alene, Idaho, miners dumped 60 million tons of toxic metals into waterways, but state officials are fighting a Superfund cleanup, fearing a stigma that might hurt tourism. In New York, General Electric, which contaminated 40 miles of the Hudson River with cancer-causing PCBs, has hired high-profile attorney Laurence Tribe to convince federal courts that the Superfund law is unconstitutional. And in New Jersey, where the rabbits frolicking around the Chemical Insecticide Corp. plant once grew green-tinged fur, cleanup funds were restored only after locals sent green plush bunnies to members of Congress.

At Tar Creek, many residents have given up hope. Even the EPA, which has spent $107 million at the site, isn't sure if it can ever be repaired. "We don't have an off-the-shelf remedy," says EPA Superfund official Randy Deitz. "What do you do with the enormous chat piles? When does cleanup become impracticable? We have limited resources." In a show of no-confidence, the Oklahoma legislature last week passed a $5 million buyout for all families with children under 6. John Sparkman, who heads the Tar Creek Steering Committee, a group of buyout supporters, veers between cynicism and despair. "They think we're poor white trash," he says bitterly, driving past Picher's boarded-up storefronts. "The votes here don't affect any federal election--so why bother? We've agitated till we can't agitate anymore." Meanwhile, at Tar Creek, the toxic dust keeps blowing in the wind.

Read more: http://www.time.com/time/arts/article/0,8599,1917099,00.html#ixzz18xaUhjjn

Pencils and Trees

Marina Nechayeva
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

Students will see how topics they learn in class tie in together and can be used to solve real life problems. They will practice their skills and reinforce their ability to solve multistep word problems involving proportions, operations with decimals, finding averages, evaluating algebraic expressions and approximating.

Math Topics
Applications with decimals. Averages, approximation, proportions, unit conversion, area and volume formulas, evaluating algebraic expressions

Purpose
Synthesis of math topics

Comments
Rather than focusing on any one particular topic, this activity is designed to enhance students' problem solving skills

When to Introduce
Week 8, or after operations with decimals have been covered

Activity Time Frame
About 4 hours, over a period of 2 weeks

Reflection

In this activity, students tackled problems which required them to go through a sequence of steps to arrive at an answer. Rather than simply following the steps handed to them by the instructor, working in small groups, students were prompted to come up with the sequence of steps on their own. This task is quite challenging for many students who are not used to solving multistep problems this way. While some resented the difficulty, the majority found the task quite engaging. In this process, the instructor must offer considerable assistance to groups and alternate between group work and classroom discussion.

The main purpose of this activity was to develop students' problem solving skills, one of the most critical goals of the course. The students showed clear, sometimes dramatic improvement in their problem solving ability. Some students, who had not even attempted to do word problems on the midterm exam or had simply guessed the answers, did well on the final exam.

This activity also served to develop and reinforce the students' computational skills. While engaged with the project, students demonstrated marked improvement in their ability to perform arithmetic operations with decimals. However, the long term effect of the activity in this area was not as significant as I had expected: 2 weeks after the end of the activity, some students appeared to have forgotten how to divide two decimals. On the other hand, the students' understanding of the conversion of units of measurement improved noticeably and lasted at least until the end of the course.

I was surprised to find that most students were completely unfamiliar with the metric system. As a result of this exercise, many acknowledged that calculations were easier in the metric system.

Overall, students responded positively to the activity. They enjoyed watching the video and appreciated the absence of reading tasks. The biggest challenge was to make sure students completed all parts of the assignment and assembled their work in the digital format to be deposited in their e-Portfolios by the deadline. Posting the handouts on Educo was helpful but not sufficient.

Activity Overview

Step 1 – Introduction and Motivation (5 min)
First, students are asked to guess what 500 year-old small portable device is still widely used today and can be found in offices, classrooms, hospitals, court-rooms, libraries, space-stations and just about anywhere else. The instructor elicits and/or provides the answer (a lead pencil) and asks students to guess how many pencils are produced each year in the U.S. For all the remaining activities, students alternate between group work and whole class discussion.

Step 2 – Group Work (10 min.)
Students work together on Handout #1 to decide what additional information they need, and what steps they must take to answer Question #1: How many pencils are made in the U.S. each year?

Step 3 – Class Discussion (10 min.)
Students share ideas about the "missing" information (such as, the length of the equator, the length of a pencil, and conversion factors for unit) which students can either quickly find on the Internet or which can be provided by the instructor.

Step 4 – Group Work (20 min.)
Groups are assigned either Handout #1A (English system) or Handout #1B (metric system) to calculate the number of pencils produced each year in either the English or the metric system.

Step 5 – Homework
Students complete both handouts. For extra credit, students write a reflection essay in which they discuss the discrepancy between the two estimates, and the advantages/disadvantages of working with the metric system.

A similar pattern of small group and whole class discussion is followed in the second and third classes. First, the class checks the homework. Students then watch the video *How Pencils Are Made* at http://science.discovery.com/videos/how-its-made-pencils.html. The instructor and students comment on the video and exchange additional facts about the trees used to make pencils.

The instructor then poses Question #2: How many trees are cut yearly for the purpose of making pencils? This initiates another cycle in which students work in small groups to figure out what additional information they need to answer that question (see Handout #2), and share their ideas as a class. Two separate groups are assigned Handouts #2A (English system) and #2B (metric system). Two group representatives present their group findings and record them on the board. The results from groups that worked on the same task are compared and summarized. The class discusses the steps required in putting the data together to answer Question #2.

Handouts #3 (homework) and #4 (extra-credit homework) are distributed and Handouts 2 and 3 are posted on Educo. The homework is presented and discussed during the third class. Students are urged to deposit their homework in their ePortfolios, including Handout #4 for extra credit, by the deadline.

Materials and Resources

- Handout #1: How many pencils are produced in the USA each year?
  - Handout #1A: Number of pencils calculated in the English system
  - Handout #1B: Number of pencils calculated in the metric system
- Handout #2: How many trees are cut down to produce that many pencils?
  - Handout #2A: Volume of a California Incense Cedar Tree (English system)
  - Handout #2B: Volume of a Pencil Slat (metric system)
- Handout #3: Homework – How many trees are cut down in the US each year to make pencils?
- Handout #4: Extra Credit – Estimating the Age and Growth Rate of the California Incense Cedar Tree
- The Science Channel Videos. (2009, July 24). *How it's made: Pencils* [Video file]. Retrieved January 28, 2011, from http://science.discovery.com/videos/how-its-made-pencils.html
- Suggested websites:
  - California Cedar Products Company. (2000). Retrieved January 28, 2011, from http://www.calcedar.com/
  - Pencils.com. (2010). Retrieved January 28, 2011, from http://www.pencils.com/

Handout #1

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Question #1: How many pencils are produced in the USA in one year?

Fact
The number of pencils produced in the USA in one year is sufficient to circle the Earth (around the equator) NINE TIMES, putting pencils tip to end.

What additional information do we need?	What steps do we need to take?

Handout #1A (English system)

- A standard pencil is about 7 inches long.
- The Equator is approximately 24,901.5 miles in length.
- 1 mile = 5,280 ft.

Handout #1B (metric system)

Facts

- A standard pencil is about 18.3 cm long.
- The length of the Equator is approximately 40,075 km.
- 1 km = 1000 m

Handout #2

Nechayeva | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Question #2: About how many trees are cut to make that many pencils?

Facts

- Approximately 2,040,000,000 pencils are made in the USA each year.
- Almost all pencils are made from California Incense Cedar trees, which are considered a renewable resource and are sustainably harvested.
- The average life span of a California Incense Cedar is close to 1,000 YEARS!
- The trees are cut and made into pencil slats; 9 pencils come out of each slat.
- You can get additional facts about California Incense Cedar trees at www.calcedar.com.

What additional information do we need?	What steps do we need to take?

Handout #2A: Volume of a California Incense Cedar Tree (English system)

Fact: The height of a mature cedar tree ranges from 40 to 50 ft, while its diameter measures 8 to 12 ft.

1. Find the average height, h, and the average radius, r, of a mature cedar tree.
2. Use the values you obtained for r and h with the formula V=1/3 ϖ r2 h to estimate the volume, V, of timber produced from 1 cedar tree (in ft3). Use ϖ =3.14. Round the answer to the nearest integer.
3. If v is the volume of wood (in ft3) in one pencil slat, give an expression for n, a number of slats produced from one tree.

Handout #2B: Volume of a Pencil Slat (metric system)

Facts

- A standard slat for making pencils is a 0.5 cm thick rectangular piece of cedar wood, 18.3 cm long and 7.2 cm wide.
- Each standard slat is used to produce 9 pencils.

1. Compute the amount (volume) of wood contained in one pencil slat (in cm3). Round to the nearest integer.
2. If V is the volume of timber produced from one cedar tree (in cm3), give an expression for n, the number of slats produced from 1 tree.

Handout #3 – Homework

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In Handouts #1, 1A, and 1B, you figured out how many pencils are made each year in the USA. Using that number, and the work you did on Handouts #2, 2A, and 2B, you can now answer the question: ***About how many trees are cut to make that many pencils?***

Suggested Steps

1. Find n, the number of slats obtained from one tree and round to the nearest thousand.

2. Find N, the number of pencils obtained from one tree.

3. Find the number of trees cut to make all the pencils.

Handout #4 – Extra Credit

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Estimating the Age and Growth Rate of the California Incense Cedar Tree

Facts (Source: www.calcedar.com)

- The normal life span of a cedar is 500-1,000 years.
- Cedars grow to be 70-150 ft tall.

1. A cedar tree grows pretty fast, at a rate of 8–12 inches per year until it reaches 6 ft. Estimate how long it takes a cedar to reach the height of 6 ft.

2. After the initial "growth spurt," the growth rate of a cedar slows to a crawl. Assume a cedar tree is 100 ft tall at 600 years. What was its average rate of growth, after it attained the height of 6 ft?

3. Use this figure to estimate the age of a 45 ft tall cedar tree (45 ft is the average height of a tree cut to make pencils.)

Answer Key

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Handout #1

What additional information do we need?	What steps do we need to take
Length of the equator, E Length of a pencil , P	1. Express E and P in the same units. 2. Divide E by P to get the number of pencils needed to circle the equator. 3. Multiply the result by 9.

Handout #1A

1. Ex: E= 131,479,920ft; P= 0.58 ft
2. E/P = 226,689,517 pencils
3. 2,040,205,653 or approx. 2,040,000,000 pencils.

Handout #1B

1. Ex: E= 4,007,500,000 cm; p=18.3 cm
2. 229,000,000 pencils;
3. 2,061,000,000 pencils

Handout #2

What do we need?	How to proceed
V, Volume of a tree v, Volume of a pencil slat Number of pencils made each year (from 1B)	1. Express V and v in the same units. 2. Divide V by v to get n, the number of slats made from 1 tree. 3. Multiply n by 9, to get N, the number of pencils made from 1 tree. 4. Divide the number of pencils made each year by N, to get the number of trees cut each year.

Handout #2A

1. h=45ft , r=5ft
2. 1178 ft^3
3. 1178/v

Handout #2B

1. 66 cm^3
2. V/66

Handout #3

1. v=66 cm^3 and V = 31,806,000cm^3
2. n=V/v = 484,848 slats
3. N= 4,363,632
4. # trees = 2,061,000,000 /4,363,632 = about 472 trees

Paper or Plastic?

Dong Wook Won
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Project Quantum Leap

Objectives

The objective of this activity is to have students come to a decision based not on their perceptions but on concrete numerical facts obtained through the application of their mathematical skills. Having gained all the necessary information, analyzed the problem and made their own choices, students write a paragraph expressing and supporting their opinion.

Math Topics
Decimals, proportions, scientific notation

Purpose
Motivation

Comments
Activities consist of class discussions, homework exercises and writing assignments

When to Introduce
Week 9

Activity Time Frame
Two weeks, 30 minutes to one hour each week to discuss activities

Reflection

It was very interesting to observe how the students' choice of shopping bags changed after the projects. Before I gave students the handouts, we had briefly discussed their preferences for every day shopping bags. In this first discussion, I let them express their opinions freely. After they completed the handouts, we had a short second discussion on the same question. This time, I asked students to support their opinions with arguments based on the numerical facts they had learned while doing their projects.

To my surprise, many students said they preferred to use plastic bags because they cost less and contribute less to pollution and global warming. Some students advocated using their own cloth shopping bags. We discussed the advantages and disadvantages of using cloth shopping bags but did not reach a conclusion.

Activity Overview

Contrary to what intuition might lead us to believe, there is a claim that using plastic shopping bags can be more environmentally-friendly than using paper shopping bags. In this activity, students analyze and evaluate the validity of this claim, thereby reviewing math in the context of their everyday choices.

Activity

In preparation for this activity, the instructor conducts a brief survey in class asking students: "What type of shopping bag do you prefer for everyday shopping: paper or plastic?" In the follow-up discussion (20-30 minutes), students talk about their preferences and the reasons underlying their choices. After the discussion, the homework reading and handouts are distributed. There are four parts to the remainder of this activity:

Part I
Students have one week to read and complete the problems and handouts. Specifically, students read a short article about the controversy over paper and plastic shopping bags. They are asked to write one paragraph responses to several questions about the advantages and disadvantages of paper vs plastic.

Part II
Students then analyze a series of numerical facts about paper and plastic bags, solving decimal and proportion problems and performing calculations using scientific notation. The instructor may choose to model one problem-solving activity. Students are asked to show all computation procedures on separate worksheets. After they complete the handouts, the instructor goes over the problems, discussing any difficulties students might have had.

Part III
In the Reflection section, students are asked to write two paragraphs in which they state their decision and provide supporting evidence.

Part IV
Having finished the reading, mathematics and writing assignments, students participate in a final class discussion about the use of paper versus plastic bags. In particular, the discussion highlights the students' ability to use numerical and other data to reason and come to conclusions as well as to suggest creative ways of resolving this issue.

Materials and Resources

- Handout
- Reading: National Cooperative Grocers Association. *Checkout Choices: The Paper vs. Plastic Controversy*. Retrieved February 18, 2010, from http://www.lindenhills.coop/files/CNS_Paper_or_Plastic.pdf
- Reference: Nashville Wraps. *Paper Bags Versus Plastic Bags – Real Numbe*rs. Posted April 17, 2008. Retrieved February 18, 2010 from http://www.nashvillewrapscommunity.com/blog/2008/04/paper-bags-versus-plastic-bags-real-numbers/

Handout

Won | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Part I

After reading "Checkout Choices: The Paper vs Plastic Controversy," in response to the questions below, write short paragraphs expressing your thoughts about this controversy

1. What are the advantages of using paper shopping bags?

2. What are the advantages of using plastic shopping bags?

3. Can you suggest your own solution to this controversial problem?

Part II

The following table shows some numeric facts about paper and plastic bags. Study the table, and then respond to the questions below:

1,000 Grocery-Size Shopping Bags

	Paper	Plastic
Weight	140 lbs.	15 lbs.
Cubic Feet	17.8 feet3	0.4 feet3
Cost	$230	$35
Shipping	$28	$3
Total Cost	$258	$38
Diesel used in transit	0.58 gallons	0.06 gallons
Gas Emissions	3.225 lbs. solids	1.62 lbs. solids
Petroleum used	3.67 lbs.	1.62 lbs
BTUs required	1,629,000	649,000

Source: http://www.nashvillewrapscommunity.com/blog/?p=46

1. What is the weight of one grocery-size paper shopping bag? What is the weight of one grocery-size plastic shopping bag?

2. Suppose a supermarket needs 200,000 shopping bags. How much will they weigh if the supermarket decides on paper shopping bags?
3. Find the total cost of making 500,000 paper bags and the total cost of making 500,000 plastic bags.
4. How much does it cost to ship 500,000 paper bags? How much does it cost to ship 500,000 plastic bags?
5. Approximately what amount of greenhouse gas emissions are generated to make one grocery-size paper shopping bag? Approximately what amount of greenhouse gas emissions are generated to make one grocery-size plastic shopping bag? Write the answers in scientific notation.
6. Assume you own a big supermarket and you need approximately 3,000 shopping bags per day. According to the above table, how much petroleum is used to produce a one month (30 day) supply of paper bags? How much petroleum is used to produce a one month supply of plastic bags? Calculate these problems using scientific notations.

Part III – Reflection

Consider what you have read and learned from the article, the math you've done, and from answering the questions above. Now, in at least two paragraphs, write your responses to the questions below:

1. One solution for the shopping bag controversy is to carry your own shopping bag instead of using disposable shopping bags. Practically speaking, however, not many people actually carry their own shopping bags. What do you think the problem is? Can you make a suggestion to remedy this situation?

2. Having discussed the pros and cons of paper vs. plastic shopping bags, which have you now decided to choose? If you have changed your mind regarding shopping bags (See Part I), what motivated you to change? If you have not changed your mind, explain why. In either case, explain your thinking in a short paragraph.

Reading: Checkout Choices: The Paper vs. Plastic Controversy

Won | Introduction to Algebra – Energy and the Environment: Global Challenge (MAT095)

Excerpted from: National Cooperative Grocers Association. *Checkout Choices: The Paper vs. Plastic Controversy*. Retrieved February 18, 2010, from http://www.lindenhills.coop/files/CNS_Paper_or_Plastic.pdf

Who would have thought that choosing between paper and plastic at the checkout would present such a dilemma? For a while the environmentally conscious were convinced that paper was the more ecological choice. (It certainly seems more natural, as a renewable, recyclable plant product.) Some communities have even banned the ubiquitous plastic shopping bag. Research hasn't exactly confirmed the ecological superiority of paper, however. In fact, some experts provide solid evidence that plastic is sometimes the more ecological choice.

Of course, both plastic and paper bags impact the environment, using natural resources and contributing to greenhouse gas production in their manufacture, transportation, and disposal. Life cycle analysis is what scientists do to figure out the environmental impact of an item. Plenty of these have been conducted on plastic and paper bags, but the information generated can be tricky to compare. For example, when fully assessing the impact of a bag, you need to know if it's made from recycled or virgin materials (and if paper, whether the timber was harvested from a sustainable forest), how far the manufacturing supplies will travel, and how many miles the bag will travel to the final consumer. To assess the carbon footprint of production, you need to know the manufacturer's environmental policies. And when gauging the long-term impact of the product, it depends in part on whether the bag will be reused or recycled or composted or dumped in the landfill. Keeping the fact that such variables exist in mind, here is just some of the key information about both plastic and paper bags:

Plastic bags:

- Cause less global warming pollution and have less of an impact on biodiversity and water, according to scientists at the National Resources Defense Council (NRDC). For example, plastic bags use 40 percent less energy during production and less than 4 percent of the water used to make paper bags. And plastic bags generate 79 percent fewer greenhouse gas emissions than composted paper bags.
- Cost less to transport, saving on fuel costs. In fact, it would take about seven trucks to transport the same number of paper bags as a single truck of plastic bags, according to The Environmental Literary Council.
- Take up less landfill space. Plastic bags account for about 9 to 12 percent of waste volume, while paper occupies about half of overall landfill volume.
- Take less energy to recycle. It takes 91% less energy to recycle a pound of plastic than it takes to recycle a pound of paper.

On the other hand:

- Ninety percent of grocery bags are plastic, which is made from petroleum. It takes 12 million barrels of oil to make a year's worth of plastic bags (100 billion of them) for Americans.
- Five of the top six chemicals that produce the most hazardous waste (according to EPA rankings) are used in plastics production.
- Less than 5 percent of plastic bags are recycled. About 4 billion plastic bags are thrown away -- littered throughout the world -- each year. Tied end to end, they could circle the earth 63 times. Instead they hang from fences and trees, blow across streets and fields.
- Because recycling plastic is expensive and time-consuming, many of the plastic bags collected for recycling are shipped for incineration to countries with lax environmental laws.
- When improperly disposed of, plastic bags cause problems in coastal areas, where they threaten sea life for as long as 1,000 years while the plastic remains in the water. Sea turtles mistake them for jellyfish and as many as one million sea creatures are killed each year by plastic bags, which also clog sewer pipes and cause stagnant, unhealthful water for humans.
- Plastic does not break down in the landfill. It will always be there. Even biodegradable plastic -- which is made of wood fibers mixed with plastic fibers -- leaves tiny plastic pieces in the earth.

Paper or Plastic?

Paper bags:

- Can hold more than plastic bags, if packed well.
- Are more often recycled than plastic bags. According to the EPA, Americans currently recycle 19.4% of paper bags but only 0.6 percent of plastic bags. (Granted, both numbers are too low!)
- Are biodegradable. While modern landfills don't allow for this process to occur as it should (the bags are buried and receive no air and sunlight for decomposition), paper bags do naturally break down -- as mulch in the garden, for example.
- Do not rely on petrochemical production.
- Can be produced from sustainable forests.

On the other hand:

- The paper industry has an enormous environmental footprint. It takes more than four times as much energy (2,511 BTUs) to produce a paper bag as it does a plastic bag (594 BTUs). And paper bag production generates 50 times more water pollutants and 70 percent more air pollutants than the plastic bag production.
- About 14 million trees were used in 1999 to make 10 billion paper bags for Americans.

And when forests are cut down to make paper, major absorbers of greenhouse gases are eliminated.

- A paper bag generates greater methane emissions in the landfill than a plastic bag.
- For strength, most paper grocery bags are made from virgin pulp, not recycled materials."

2

ELEMENTARY ALGEBRA

Problems and Issues in Public Health (MAT096)

Project Quantum Leap

This course provides a careful treatment of elementary algebra, beginning with the line/linear equation, ending with the parabola /quadratic equation, and emphasizing the interplay between geometric and algebraic representation. Topics include graphing, systems of linear equations, functional concepts, rules of exponents, polynomial algebra, factoring, rational expressions, complex fractions, radical expressions, and the quadratic formula. Applications to linear and quadratic modeling are featured.

Projected Deaths for Selected Causes to 2030

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Project Quantum Leap

Objectives

Through studying graphs and the trends they indicate, this assignment will help our students to become aware of certain deadly diseases that people throughout the world face today. Students will apply and review their ability to solve a system of linear equations and find the value of a function. At the end of this project, students should be able to see the relevance of math to real-life situations and be able to interpret a graph and draw a critical conclusion from it.

Math Topics
Linear equation, solving an equation, solving systems of equations, functions, and square roots

Purpose
Synthesis

When to Introduce
Week 9

Activity Time Frame
One hour class-time and two weeks to complete the whole assignment

Reflection

This activity is based on a graph provided by the World Health Organization (WHO). The WHO website is a good source to obtain important information. The caption of the graph provides useful reading material, as well. Students will be able use the information to find the number of deaths due to HIV/AIDS. This is very useful for our students because during the course of their college life, they have to take the CUNY Proficiency Exam (CPE) where they will have to do the same thing: read a passage, draw information from the reading and use the information to answer some questions.

The mobilization against HIV/AIDS and the movement to raise public awareness was more active before 2005. Although such efforts still continue today, many people have a misconception about the AIDS epidemic. They seem to think that it is over and thus do not take HIV/AIDS prevention seriously. Many young kids in our schools are not aware of the disease at all. Some people erroneously think that the number of HIV cases is decreasing. This project is a wakeup call for our students because it clearly shows that the number of deaths related to HIV/AIDS is actually increasing.

This project should be assigned in the ninth week of the semester. It is a very comprehensive activity as it contains the major topics of MAT096 (linear equations, evaluation of expressions, functions, systems of equations, solving an equation, and square roots). The activity should be introduced after covering all of these topics. It is also wise to introduce square roots before assigning this project.

Activity Overview

The project is introduced after teaching the concept of square root and its properties. The instructor should review previously taught topics, such as solving systems of equations and linear equations. The handout has a number of different graphs that the instructor has to explain in class when introducing the project because MAT096 students are not expected to be familiar with the appearance of various functions on a graph.

Because the project is assigned late in the semester, the instructor might give students a chance to turn in a draft before the final paper. At the end of the first week, the instructor should collect the first drafts, return them with comments and suggestions to students, and discuss some common mistakes in class, then give another week for completing the project.

It is also helpful to create a forum on an electronic discussion board where students can discuss the development of their papers. The instructor should participate in the discussion forum and reply to students' comments. I have also used email exchanges to keep students on track, but I strongly encourage using the discussion board on an electronic course management system for this project.

Materials and Resources

1. Handout
2. Reading: World Health Organization. (2007). *Ten statistical highlights in global health, Part 3 – Future health: Projected deaths for selected causes to 2030*. Retrieved January 29, 2009, from World Health Organization Statistical Information System (WHOSIS): http://www.who.int/whosis/whostat2007_10highlights.pdf
3. Google or seach engine
4. Class notes

Handout: Projected Deaths for Selected Causes to 2030

Gbedemah | Elementary Algebra – Problems and Issues in Public Health (MAT096)

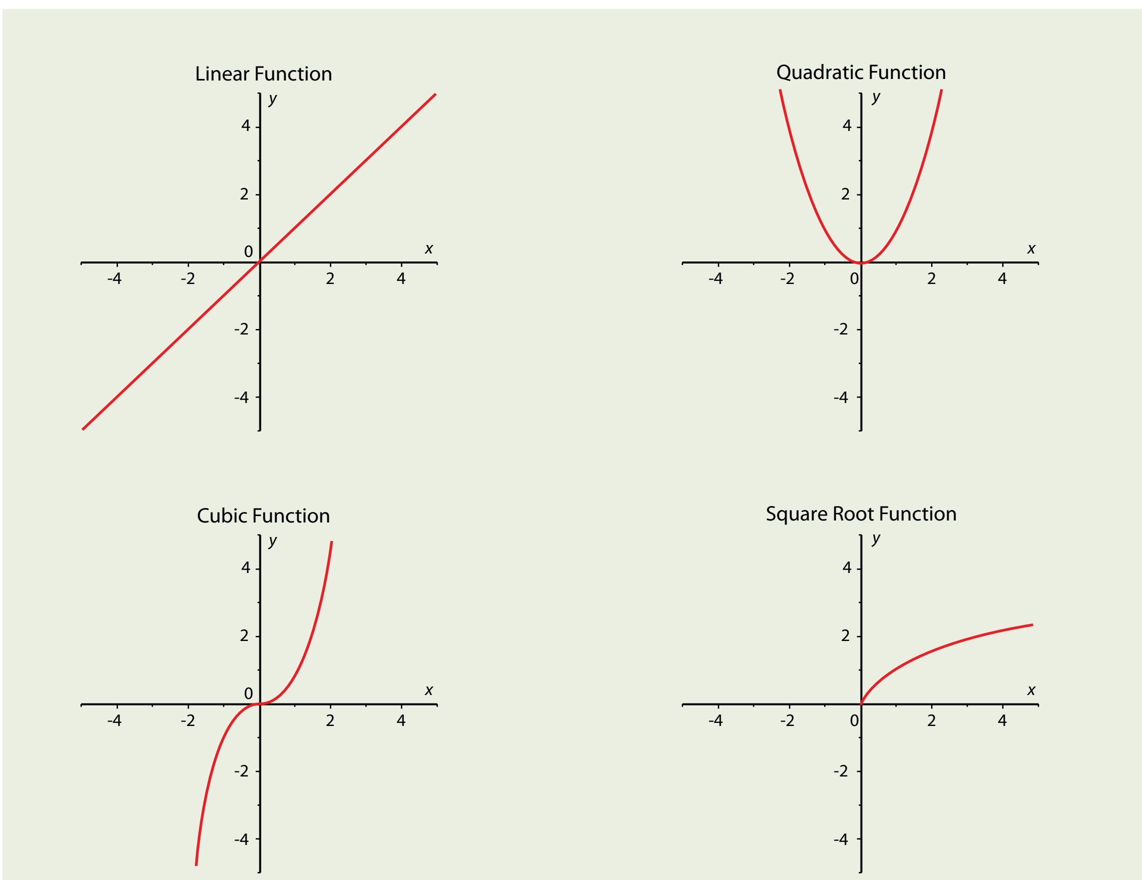
Introduction

Given a graph (or a set of points), mathematicians can find the best-fit equation that represents such a graph. Having such an equation allows mathematicians to analyze the behavior of the graph. This technique can be applied to a real-life situation so that one might be able to predict the trend. In this project, we will try to find the approximate linear and non-linear equations to project the number of deaths caused by different diseases. Please read the statistics in Part 3, page 12 of the World Health Organization article, *Ten statistical highlights in global health.* Part 3 is called *Future health: Projected deaths for selected causes to 2030:* http://www.who.int/whosis/whostat2007_10highlights.pdf.

Questions

Based on the reading, answer the following questions.

1. Classify the different types of diseases on the graph as communicable or non-communicable. You might answer this question by using references in our library or searching on the Internet.



2. Based on the graphs, which one(s) look linear and which one(s) non-linear?
   a. Classify the linear functions as either increasing or decreasing. Give two reasons why that is the case.
   b. Do you think the non-linear function is quadratic, cubic or square root function

t	9	10	15	16	20	25	30
H(t)							

3. Suppose the HIV/AIDS graph starting from 2010 can be described by a square root function of the type $H(t) = \sqrt{a} + b$ where a, b are constant, $H(t)$ is the number of projected global deaths (in millions) in years after year 2000. Solve for the constant using the points $(10,2.5)$ and $(30,6.5)$, assumed to be on the graph. Round your answer to 4 digits after the decimal point.

4. Use your result from part (3) to fill in the table below.

5. Based on your calculation or analysis, do you think that at some point in time, the number of deaths due to HIV/AIDS will decrease? Give a brief explanation.

6. Approximately in what year will the number of deaths due to HIV/AIDS in the world reach 4 and 6 million?

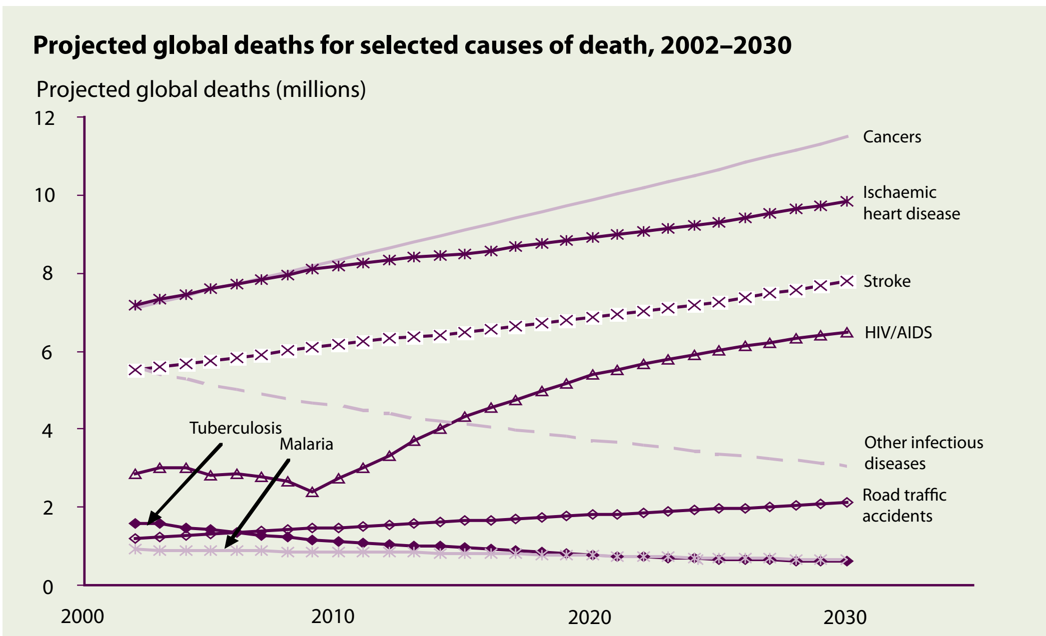
7. Reflection: With the advancement in medicine, one would expect a significant decrease of deaths due to HIV/AIDS. Based on the information provided by the WHO, this is not the case. Write an essay of at least half a page. Describe (a) possible reasons why HIV/AIDS cases are still increasing; and (b) what a world citizen can do to decrease the number of deaths due to HIV/AIDS.

Reading: Projected Deaths for Selected Causes to 2030

Gbedemah Elementary Algebra – Problems and Issues in Public Health (MAT096)

Source: World Health Organization. (2007). *Ten statistical highlights in global health, Part 3 – Future health: Projected deaths for selected causes to 2030*. Retrieved January 29, 2009, from World Health Organization Statistical Information System (WHOSIS): http://www.who.int/whosis/whostat2007_10highlights.pdf

Future health: projected deaths for selected causes to 2030



Predicted statistics have an important and useful role in helping to inform planning and strategic decision-making, and in prioritizing research and development issues. According to projections carried out by WHO and published in early 2006, the world will experience a substantial shift in the distribution of deaths from younger age groups to older age groups, and from communicable diseases to noncommunicable diseases during the next 25 years. Large declines in mortality are projected to occur between 2002 and 2030 for all of the principal communicable, maternal, perinatal and nutritional causes, with the exception of HIV/AIDS. Global deaths from HIV/AIDS are projected to rise from 2.8 million in 2002 to 6.5 million in 2030 under a baseline scenario that assumes antiretroviral drug coverage reaches 80% by 2012.

Although age-specific death rates for most noncommunicable diseases are projected to decline, the ageing of the global population will result in signifi cant increases in the total number of deaths by most non-communicable diseases over the next 30 years. Overall, noncommunicable conditions will account for almost 70% of all deaths in 2030 under the baseline scenario. The projected 40% increase in global deaths resulting from injury between 2002 and 2030 is predominantly due to the increasing number of deaths from road traffic accidents.

The four leading causes of death globally in 2030 are projected to be ischaemic heart disease, cerebrovascular disease (stroke), HIV/AIDS and chronic obstructive pulmonary disease. The total number of tobacco-attributable deaths is projected to rise from 5.4 million in 2005 to 6.4 million in 2015 and to 8.3 million in 2030. Tobacco is projected to kill 50% more people in 2015 than HIV/AIDS and to be responsible for 10% of all deaths.

Basal Metabolic Rate

Arnold Glick
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Project Quantum Leap

Objectives

Through studying graphs and the trends they indicate, this assignment will help our students to become aware of certain deadly diseases that people throughout the world face today. Students will apply and review their ability to solve a system of linear equations and find the value of a function. At the end of this project, students should be able to see the relevance of math to real-life situations and be able to interpret a graph and draw a critical conclusion from it.

Math Topics
Linear equations and functional notation

Purpose
Synthesis

When to Introduce
Week 4

Activity Time Frame
This activity will span the middle six weeks of the semester

Reflection

The BMR formulation is rather advanced for this basic skills course. However, given the common concerns about exercise and weight control management, I thought the topic would be both interesting and useful to students. Furthermore, since the major theme of our PQL project was nutrition and public health, I felt it was important and realistic to introduce this concept. The first part of this project emphasized the ability to calculate the BMR for different variable values. In the second part, students applied an activity factor to the BMR result to determine a total metabolic value (energy expenditure). The activities focus on many of the topics in the MAT096 syllabus including: linear equations, concept of a slope, numerical calculation, graphing, and graph interpretation.

The BMR function is a linear function which requires the manipulation of three variables (height, weight, and age). The discussion of the influence of each variable was completely new to the students. They were used to performing computations to obtain a result but apparently not familiar with interpreting the consequences of changes in a variable, particularly when the variable represents a physical entity. To address this problem we performed a number of calculations changing one variable at a time to demonstrate that variable's influence upon the result.

The second part of this activity required active student participation. Students were asked to calculate the BMR for family or friends. This process engaged many of the students. Some indicated that their family and friends were impressed by the nature of this project and this reinforced the students' interest and participation.

In the third part, students read and interpreted an activity level chart, then estimated the activity level of the selected individual and applied the corresponding factor to calculate total energy. This phase showed students how results output from one process or equation are often used as input for another equation or process.

Although students had difficulty interpreting the equation because of the number of variables, a good majority of the students were fascinated and remained engaged. In the future, in order to address the interpretation issue, I will re-introduce the equation using only one variable, perform several numerical calculations, and discuss the results. Then, I will introduce a second variable to the equation and recalculate the results showing how the new result is influenced by the additional variable. Rather than having students attempt to use all three variables in the BMR formula at once, I will use a step-by-step approach. I believe students will benefit from this more staged approach. Furthermore, I will have the students perform calculations fixing two variables at a time, vary the third as I did in my demonstration, and then graph the results. Since learning graphing skills occurs early in the course, this activity will fit right in. Initially, I had the students work individually; in the future I will have students work in groups of two or three. Peer activity should strengthen their involvement in the project and increase their understanding of the math concepts.

The topic was introduced late in the semester (8th week) and I did not have enough time to adequately cover all the materials in the detail I wanted. I had purposefully introduced this activity in the 8th week so that the students could develop some mathematical maturity and understanding. From this first experience, I realized the project could be introduced much earlier in the semester and consequently be developed more slowly. Although I did not achieve all my objectives, students learned many mathematical concepts such as interpreting a graph, understanding the effects and consequences of variables on a calculation, and finally the concept of using a relatively simple and understandable mathematical model to describe energy expenditure. I consider this a solid topic, which evokes class participation and interest, develops mathematical maturity and awareness, but requires a significant amount of instructor participation.

Activity Overview

By the end of the first 3–4 weeks of the semester, the students have been exposed to linear equations, graphing, and some functional notation. This project should be introduced at that time and continue for approximately the next five weeks. The timeline for the project can be structured as follows:

First Week

- Introduce the concept of multivariable calculations.
- Graphing (one variable, keeping the others fixed) and interpretation.

Second Week

- Present and discuss the BMR formula.
- Compare the corresponding coefficients of the variables between the men's and women's formula.
- Discuss the BMR graph for men.

Third Week

- In class, perform some BMR calculations and assign some examples for the students to do.

Fourth Week

- Assign students the task of calculating and graphing a BMR for women similar to the one discussed in class.
- Have the students research the equation on the Internet and write a short paper describing and discussing the formula and how it is used.

Fifth Week

- Assign a problem set where the student calculates the BMR for family members and friends.
- Introduce and discuss the activity chart and have the students calculate the total estimated energy consumption of the people they analyzed in their BMR calculations.

Sixth Week

- Research and be prepared to discuss the differences between the Harris-Benedict equation and the Mifflin equation.
- Final discussion comparing the total energy expenditure of the people in their sample to their weight status.

Materials and Resources

- Handout
- A calculator to help perform calculations
- Internet and computer access

The BMR equation is given in the handout. For instructors who are interested in knowing more about BMR, the following references provide detailed information:

- Cole, T. J. & Henry, C. J. K. (2005). The Oxford Brookes basal metabolic rate database – a reanalysis. *Public Health Nutrition,* 8 (7a), 1202–1212 . Retrieved January 29, 2009, from http://journals.cambridge.org/action/displayFulltext?type=1&fid=634672&jid=PHN&volumeId=8&issueId=7a&aid=587472
- Mifflin, M. D. ,St Jeor, S. T., Hill, L. A., Scott, B. J., Daugherty, S. A. & Koh, Y. O. (1990). A new predictive equation for resting energy expenditure in healthy individuals. *The American Journal of Clinical Nutrition*, 51, 241–247. Retrieved January 29, 2009, from http://www.ajcn.org/cgi/reprint/51/2/241.pdf

Handout: The Mathematics of Energy Expenditure

Glick | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Your body uses energy (that is, it burns calories) all the time, whether you are at rest or exercising.

For this activity we are going to examine a formula that measures the amount of energy the body needs at rest and then apply another formula to estimate the energy used for various levels of activity. This analysis is important in order to determine the necessary calories you need to maintain your body weight or to lose weight. If you burn more calories than you take in, you will lose weight, and conversely, if you take in more calories than you use, inevitably you will gain weight. If you have a "normal energy balance," consumption and expenditure is in balance and the result is no weight gain or loss.

Basal Metabolic Rate

The Basal Metabolic Rate (BMR) is the minimum number of calories your body needs each day (twenty-four hours) to sustain all life functions. It is calculated while the body is at rest and in a rest (inactive) state. The calculation is performed after the body has been in a fasting state for twelve hours. These "resting" calories, or measure of energy, represent the energy release sufficient only for the function of vital organs and necessary life support systems of the body. Or, to put it another way, it is the minimal caloric requirement needed to sustain life in a resting individual. The BMR formula uses the variables of height, weight, age, and gender for the calculation. There are two separate formulas to account for gender, but they both use the height, weight, and age variables. Only the coefficients of the variables and a numerical constant differ. A factor that the equation omits is body fat percentage (lean body mass). Leaner bodies need more calories than less lean ones. This formula is called the Harris-Benedict formula.

Although the Harris-Benedict equation has been used for almost 100 years, since the study was published in 1919, new studies have shown that in overweight or obese persons, this equation is not always accurate, as it tends to overestimate the resting energy expenditure by at least 5 percent. (There is another predictive but much more complex equation for healthy people called the Mifflin equation, published in the February 1990 issue of the *American Journal of Clinical Nutrition*.) For our discussions, we will use the Harris-Benedict equation.

Formula notation:

W = weight in pounds

H = height in inches

A = age in years

The formulas are:
BMR for men = $66.47 + 6.22W + 12.7H - 6.8A$

BMR for women = $655.10 + 4.36W + 4.327H - 4.7A$

In this formula there are three variables that affect the calculation, each having an influence upon the result. Let us examine the influence of these variables on the value of the BMR.

1. The coefficient of the age variable is negative which indicates that the age variable part of the calculation is a subtraction factor. What does this mean? The implication is that the BMR requirement decreases with age. Thus, even if your height and weight stay the same, as you grow older your minimum calorie requirement decreases.

Let's use a numerical example to examine this consequence: Consider a man and assume a constant weight ($W = 180$ pounds) and height ($H = 72$ inches). Compute the BMR at age:

a. Age 30: BMR = 66.47 + 6.22(180) + 12.7(72) – 6.8(30) = 1896 calories

b. Age 45: BMR = 66.47 + 6.22(180) + 12.7(72) – 6.8(45) = 1794 calories

c. Age 60: BMR = 66.47 + 6.22(180) + 12.7(72) – 6.8(60) = 1692 calories

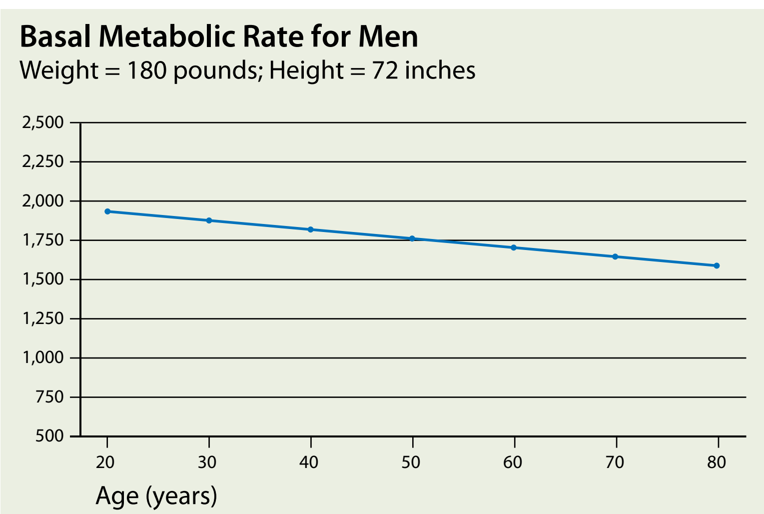
You will note there is a 102 calorie decrease (1896–1794) between ages 30 and 45 and a 204 calorie decrease (1896–1692) between the ages of 30 and 60.

Now, a 204 calorie increase between the ages of 30 and 60 may not seem like much, but remember: ***this is calories per day***. There are 365 days per year and you need to burn 3500 calories to lose a pound. This translates to:

$$\frac{(204)(365)}{3,500} = 21.3 \text{ pounds!}$$

Thus, if your activity level remains about the same at both ages, you would gain over 21 pounds in that year. Since, in general the activity level would be less at age 60 than age 30, this weight gain would be more pronounced! Displayed below is a graph of this calculation in ten-year increments starting at age 20. A table of values used to generate the graph is also included

Age	20	30	40	50	60	70	80
BMR	1964	1896	1828	1760	1692	1624	1556



Remarks

1. The graph is trending down as we expected because the coefficient of the variable ***A*** is negative. You can see this graph is linear (a straight line). Why?
   Answer: This is because the variable ***A*** is linear (its exponent is 1). Why?

2. We can infer that the BMR calculation for women will display the same type of trend. Why?
   Answer: This is because the coefficient of age in that equation is also negative.

3. Will the expected decrease for women be as pronounced as for men?
   Answer: No, because the coefficient for women is smaller (– 4.7 versus – 6.8).

4. We have learned to calculate the slope of a straight line. What is it?
   Answer: slope = $\dfrac{Rise}{Run} = \dfrac{(Y_2 - Y_1)}{(X_2 - X_1)}$ where $(X_1 - Y_1)$ and $(X_2 - Y_2)$ are two points on the line.

5. Calculate the slope of this line for the points ***(20,1964)*** and ***(20,1556)*** .You should recognize these coordinates as the age and BMR value.
   Answer: slope = $\dfrac{1556 - 1964}{80 - 20} = -\dfrac{408}{60} = -6.8$

   Remember, in this example the rise is the difference between two BMR values and the run is the difference between the corresponding age values. Does this slope value seem familiar?

   Answer: It is the value of the coefficient of the age variable! Why?

   Answer: The reason is that the coefficient of the linear variable represents the rate of change of the variable. In our case this rate is – 6.8 per year.

   Will this value change if we take two other points on the line?

   Answer: No, because the slope of a straight line is constant, regardless of the points used to calculate it.

6. For a given weight and height, a taller person will have a higher BMR value and thus use more calories. However, this factor is relatively minor. How can you tell?
   Answer: For a man the coefficient of the height variable is positive (12.7). Thus, a difference of 3 inches would correspond to an additional (12.7)(3) = 38 calories per day.

   For women, a height difference of 3 inches would also result in a calorie increase because the height coefficient is also positive but much smaller (4.327 versus 12.7). A difference of 3 inches would correspond to an additional (4.327)(3) = 13 calories per day.

Activity: Calculate the BMR for yourself and some friends and family members.

Basal Metabolic Rate: Men

	66.47	6.22 x	12.7 x	– 6.8 x	
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR

Basal Metabolic Rate: Women

	655.10	4.36 x	4.327 x	– 4.7 x	
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR
NAME	FACTOR	WEIGHT	HEIGHT	AGE	BMR

Activity: Calculate the total energy expenditure of the people described in your BMR chart. You will have to estimate their activity level and then apply the appropriate factor.

Total Energy Expenditure

As stated, the BMR calorie term represents the minimum amount of energy required for the body to maintain life support activities while at rest. But we do more than merely rest! We walk, run, exercise, and perform all types of movements which require the use of energy. How can we begin to approximate our total energy (calorie) expenditure? To be clear, the Harris-Benedict equation estimates BMR as the minimum requirement to support life functions. It is only a first step in estimating total calorie needs. As far as measuring our total daily energy requirement, we can use a method that includes activity, the so-called energy factor. This is a number based upon the level of physical activity.

General activity factors can be applied to the result of the BMR calculation to determine your total daily energy caloric expenditure. This is the amount of calories a person would need to consume in a day to maintain his/her current weight and body composition. It should be noted that the factors associated to the definition of activity levels are approximations. The chart displayed beow classifies activity level and the corresponding factor.

Activity Level	Examples	Factor
Sedentary (little or no activity)	Sitting, reading, driving	1.2
Light activity	Moderate walking	1.375
Moderate activity (moderate exercise 3–5 days/week	Fast walking, skating, easy bicycling	1.55
Very active (intense exercise, sports 5–6 days/week)	Swimming, running, basketball	1.725
Extra active (very intense exercise/sports & physical job)	Rowing, boxing, physical job	1.9

Example:
Assume a BMR of 1845. The daily caloric need for weight maintenance would be:

Activity Level	Factor	Calculation
Little or no	1.2	1845 x 1.2 = 2214
Light	1.375	1845 x 1.375 = 2537
Moderate	1.55	1845 x 1.55 = 2860
Very	1.725	1845 x 1.725 = 3183
Extra	1.9	1845 x 1.9 = 3506

Activity

Use your BMR calculations, estimate the activity level of those people, and compute their estimated total energy expenditure. Note that these calculations are only estimates. Why?

Answer: The activity level factor is an approximation and applies to an average or general level of activity.

Name	Activity Factor	BMR	Estimated Energy Expenditure

Toxic Release and Pollution: Asthma in NYC (Learning Community Version)

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Project Quantum Leap

Objectives

The main goal of this collaborative assignment, designed for a learning community (Elementary Algebra and Critical Thinking), is to encourage students to recognize how mathematical evidence (graphs and percentages) can be used to support their critical thinking arguments. This is a staged assignment, starting with an inquiry activity about environmental pollution and toxins in NYC neighborhoods, followed by a math assignment that requires students to calculate the asthma hospitalization rates in NYC and compare them to rates in the USA as a whole. In the final stage of the project, students work in groups to continue their research on asthma, and develop a final oral presentation that incorporates the previous two stages. Student groups create a wiki site about the causes, cures, and social issues related to asthma.

Math Topics
Geometric context, plotting ordered pairs (table), graphic analysis and interpretation, linear approximation, slope calculation (positive and negative)

Tools
Multimedia projector, computer with Internet access, cell phone to make the podcasts

Course Title
Introduction to Algebra (MAT096), Critical Thinking (HUP102)

Activity Time Frame
This staged project spans one semester. Toxic release podcast (in Critical Thinking class): third week of the semester. Toxic release: asthma (in MAT096 class): sixth week of the semester Asthma group project (in Critical Thinking class): seventh week of the semester.

The objective of these activities is to help students gain understanding of environmental pollutants and asthma issues using the tools of geometric context, graphic analysis, linear function, and positive and negative slopes. This assignment reinforces the use of technology (computers, web research, MS Word, Excel, scanning). In addition, students review mathematical topics and operations, such as finding and building tables, converting data into graphs and vice versa, working with ordered pairs, percentages, decimals, fractions, and ratios.

Note: If the assignment is taught in a stand-alone math class (i.e., not paired in a learning community), please refer to the next activity on Toxic Release.

Reflection

As we began to plan our learning community, we decided that the relationship among environmental pollution, global warming, and health in NYC would be an engaging topic for our students, and broad enough for us to use as a theme for our lessons and assignments. The critical thinking parts were designed to help students learn how to look at a situation from different perspectives, to evaluate the sources of information, and to support arguments using valid mathematical data.

The first part of this activity took place in the Critical Thinking class. Students created a Toxic Release podcast, grounded in web-based inquiry research and discussion on various chemical toxins in our environment. The web-based inquiry was assigned as homework and followed up on the discussion board. Pre- and post- discussions took place in class. Students were very interested in finding out about factories that produce dangerous chemicals in their own neighborhoods. In their podcasts they talked about the effect of these chemicals on their health.

The mathematical activity on asthma was introduced after students created their podcasts in the Critical Thinking class, enabling students to understand that mathematical calculations can increase their understanding and help them support their arguments. We confirmed the effectiveness of this strategy when, at the end of the semester, student groups used graphs and charts as well as their math calculations to explain various aspects of asthma in NYC in their wiki presentations.

The math assignment was titled "Toxic Release: Asthma, Facts and Numbers." We found that about half of the class was very interested in this public health issue, and therefore more engaged with the mathematical calculations. Because it was a group project, the groups discussed the work together and were able to help each other. Students returned the work before the due date and, although not required in this level of math course, many of them chose to use Excel and/or Word to graph and present their mathematical work.

Activity Overview

Toxic Release Podcast (one week)
In this web-based inquiry assignment, students develop questions that they then use to explore a situation:

1. In class, students are given a handout (Handout #1) about toxins in our environment. They read it individually and practice asking critical questions about the reading.
2. The homework assignment is to use selected websites (part of Handout #1) to research toxic chemicals in their own zip-codes. Then students write a script for a podcast.
3. In the following class, students critique each others' scripts.
4. The homework assignment is to finalize their podcast scripts and record them as Mp3 files.

Toxic Release: Asthma Facts and Numbers (one week)
The mathematical activity should be introduced after the due date of the podcast assignment.

1. In class, students are given the Asthma Facts and Numbers handout (Handout #2), which provides a brief description of the asthma problem, statistical data about NYC and the US, and graphs of the data.
2. For homework, students are asked to answer questions about asthma in NYC and the US. These questions were designed to encourage students to use math skills learned in the classroom to establish graphs and comparisons, calculate numbers from graphs, predict future values, and understand how this work could help them support their argument in the Critical Thinking project. Students are encouraged to use Excel and Word to present their work.
3. In the next class, students share their calculations and their reflections with each other in small groups.

Toxic Release Asthma Wiki Project (three weeks)

In their next Critical Thinking class, students work in groups to prepare a presentation on asthma in NYC. Students must research facts, causes, and prevention strategies.

Here are a number of ways students can be encouraged to do this assignment:

1. Interview asthma patients and nurses and record their interviews as either a Socratic dialogue or as a digital story.
2. Do Internet research on the topic and critically evaluate the websites and information on those sites.
3. Read related articles and conduct in class or online discussions about them.
4. Attend asthma-related events.

As the culmination of their research, students can create a wiki in which they display their mathematical calculations and the results of their research. Each group needs to present a well-articulated statement about asthma in NYC and use the wiki site to support their claims. The groups also need to interpret graphs and talk about how they are using mathematical evidence. These presentations should be completed in the last week of the semester.

To ensure that students make better connections between mathematical evidence and critical thinking skills, after the presentations students should also write a reflective paper based on the following questions:

1. Describe your involvement with the asthma project this semester. What did you do? How did you learn what you learned? In this analysis, you don't need to repeat any factual information about asthma. Rather, talk about what methods helped you learn.
2. How did critical thinking techniques and tools as well as mathematical techniques and tools help you in your research? In your presentation? In your ability to argue your case?
3. How do you plan to use the information you gathered about asthma in the future? How has this project helped you to be a better student, a better learner and a better critical thinker? Be thoughtful in examining about your learning process. Again, please do not write WHAT you learned, but HOW you learned it.

Materials and Resources

- Handout #1: Toxins
- Handout #2: Asthma
- Department of Health and Human Services. (2000, Summer/Fall). *Special Issue on Geographic Information Systems*. (vol 10, number 2).
- National Library of Medicine. (2006, June). *Tox Town*. Retrieved February 12, 2009, from http://toxtown.nlm.nih.gov/text_version/chemicals.php
- Native Village. (n.d.) *How to avoid the top 10 most common toxins*. Retrieved February 12, 2009, from http://www.nativevillage.org/Messages%20from%20the%20People/How%20to%20avoid%20environmental_toxins.htm
- New York City Department of Health and Mental Hygiene Childhood Asthma Initiative. (2003, May). *Asthma Facts*. Retrieved February 3, 2009, from http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf
- New York City Department of Health and Mental Hygiene. (2003, April). Asthma can be controlled. *NYC Vital Signs* (vol 2., number 4). Retrieved February 3, 2009, from http://www.nyc.gov/html/doh/downloads/pdf/survey/survey-2003asthma.pdf
- Scorecard: The Pollution Information Site. (2005). *Pollution locator smog and particulates*. Retrieved January 22, 2009: http://www.scorecard.org/env-releases/cap/
- United States National Library of Medicine. (2008, February 11). *ToxMap Environmental Health eMaps*. Retrieved February 12, 2009, from http://toxmap.nlm.nih.gov/toxmap/main/index.jsp

Handout #1: Toxins

Hassebo & Török | Elementary Algebra – Problems and Issues in Public Health (MAT096)

A toxin is a substance with the ability to cause harm at some level of exposure.

The object of this assignment is to help you think critically about an important issue: toxins in our environment and how they affect our health. You will be required to ask critical questions and then create an audio recording through which you will become more aware of the problem and offer an analysis of the issues at stake.

In this first section of this project, you will create a podcast. A podcast is a recording of a 2–3 minute presentation. The topic of your podcast will be: Effects of Environmental Pollution and Toxins on My Heath.

As critical thinkers, before we can answer such a complex question, we need to first find out as much as we can about our topic. So let's begin.

Step I: Read the following information

Environmental toxins are chemicals and other materials created largely from industry and carelessness. These chemicals have saturated our water, food, and the very air we breathe. You can't see, feel, or smell many toxins – at least, not right away. We don't realize their effects until we come down with a chronic disease after years of exposure.

- 77,000: chemicals produced in North America
- Over 3,000: chemicals added to our food supply
- Over 10,000: chemical solvents, emulsifiers and preservatives used in food processing
- 1,000: new chemicals introduced each year

The Effects of Toxins on Your Body
A study in the *British Medical Journal* says that 75% of most cancers are caused by environmental and lifestyle factors.

A report by the Columbia University School of Public Health estimates that 95% of cancers are caused by diet and environmental toxicity.

"Most Americans have between 400 and 800 chemicals stored in their bodies, typically in fat cells

Source: Native Village. (n.d.) *How to Avoid the Top 10 Most Common Toxins*. Retrieved February 12, 2009, from http://www.nativevillage.org/Messages%20from%20the%20People/How%20to%20avoid%20environmental_toxins.htm

Step II: Carefully explore the situation with questions

- Look for the toxins in your neighborhood. Click on the link to ToxMap Environmental Health eMaps: http://toxmap.nlm.nih.gov/toxmap/main/index.jsp
- Type in your zip code.

- You can zoom in and out on the map to see what toxic facilities are located in your neighborhood.

- Click on 'Identify TRI facilities' and read about the chemicals these facilities produce.
- Choose any two hazardous chemicals and toxins that are around your area.
- Research these toxins. Learn everything you can about them: where they are found, what they cause, how we can avoid them.
- You may use the following websites as you do your search:
  - The National Library of Medicine's Tox Town: http://toxtown.nlm.nih.gov/text_version/chemicals.php
  - How to Avoid the Top 10 Most Common Toxins: http://www.nativevillage.org/Messages%20from%20the%20People/How%20to%20avoid%20environmental_toxins.htm
- After you are done with your research, think about ten questions you have about this topic.

Step III: Think independently. Write the script of your podcast.

- Imagine you are a reporter for a radio station. You have no more than 3 minutes (no less than 2 minutes) of air time to report on this topic: Effects of Environmental Pollution and Toxins on My Heath. Think critically and independently. Use the guidelines in Chapter 2 of the Thinking Critically textbook and write a 1-page (double-spaced, typed) report. This will be the script for your podcast.
- Tips: As you are writing this, make sure that you don't just describe the situation. Some description is necessary, but what you need to do is use your research, evaluate your beliefs, and organize your thoughts well.
- Bring a printed copy of your script to class with you for peer-review.

Record your final podcast as an Mp3 and submit it on Blackboard for a grade.

Grading criteria:

Excellent	Competent	Needs Work	Incomplete
Podcast is well structured and discusses ideas in an organized way.	Podcast is somewhat organized, but should have a clearer structure.	Podcast is un-organized and doesn't have a clear structure.	Podcast is not completed or was not submitted on time.
Podcast is sufficient in length.	Podcast is a little shorter than expected.	Podcast is insufficient in length.	Podcast is not completed or was not on submitted on time.
Podcast addresses the assigned topic with originality of thought and independent thinking.	Podcast addresses the assigned topic but lacks originality of thought and independent thinking.	Podcast doesn't address the assigned topic and shows little or no originality and independent thinking.	Podcast is not completed or was not submitted on time.
Podcast refers to factual reports and uses interpretation, personal opinion and analysis of the situation well.	Podcast refers to factual reports, and uses some interpretation, personal opinion and analysis of the situation.	Podcast rarely or never refers to factual reports or uses interpretation or personal opinion, and lacks analysis.	Podcast is not completed or was not submitted on time.

Handout #2: Asthma

Hassebo & Török | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Background Information:

In the United States the number of people with asthma is increasing rapidly. Asthma affects approximately 17.3 million Americans, including 5 million children under the age of 18. Of these, 1.3 million are younger than five years old [USA National Institute of Medicine, 2000]. Asthma is a huge public health problem in New York City (NYC) especially in the Bronx. The World Health Organization (WHO) estimates that more than one million cases of asthma are reported each year in NYC, and 12.5% of the population has been diagnosed with asthma. (Source: World Health Organization)

In Manhattan, more than 75% of the people live within 500 feet of a busy street or highway. In Brooklyn, over 35% of both health facilities and playgrounds are also within the 500-foot risk area. As of the year 2000, approximately 300,000 NYC children have been diagnosed with asthma. In the year 2000, NYC children were nearly twice as likely to be hospitalized due to asthma attacks as the average number of children in the U.S. Even more alarming is the fact that in central Harlem, central Brooklyn, the south Bronx, and Queens, children have been diagnosed with asthma at a rate of 20–30 %, more than double the national average. The diesel pollution risk in Queens is the tenth unhealthiest in the U.S. when compared with more than 3000 counties. (Sources: Scorecard, Asthma Facts, NYC Vital Signs)

Asthma symptoms appear in correlation with high levels of exposure to respiratory irritants such as gas, smoke fumes, vapors, aerosols, and dust. Some types of these environmental gases such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and ozone (O_3) can exacerbate preexisting respiratory symptoms.

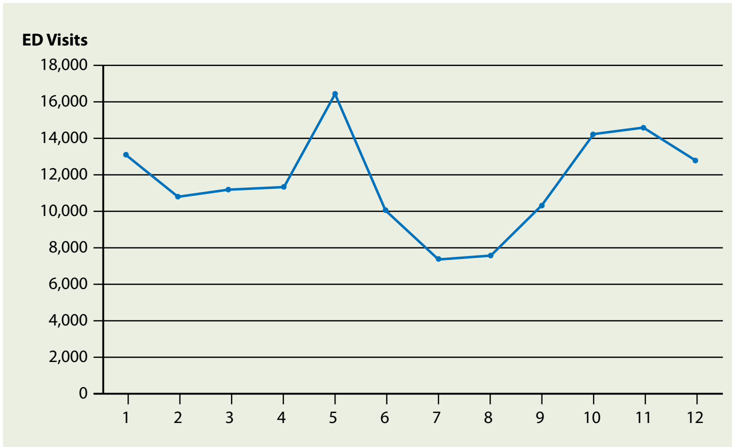
Climatic change factors and the time of year can influence the spread of asthma; for example, in 2005, statisics for emergency room visits revealed peak numbers in the spring and fall and a decline in the summer. See Fig 1 below. (Sources: Scorecard, NYC Vital Signs, Asthma Report)

Enforced by the Clean Air Act (CAA), the National Ambient Air Quality Standards (NAAQS) have been established for six criteria pollutants (O_3, SO_2, NO_2, CO, lead toxicity, and PM10 (particulate matter ≤ 10 m in aerodynamic diameter, respectively) and PM2.5 (particulate matter ≤ 2.5 m). (Source: Special Issue on Geographic Information Systems)

Controlling asthma, cancer, and bronchitis, diseases that are all affected by air pollution, depends on being able to detect and reduce air pollution. However, this is extremely difficult to do because of the uncertainties about air pollution transportation.

For Class Discussion

Fig. 1: Asthma varies over the calendar year (NY) . (Emergency Department Visits by Month)



In Class

Discuss the following questions:

a) What is asthma?

b) How many people currently suffer from asthma in NYC and worldwide?

c) How many New Yorkers were diagnosed with asthma in 2006?

d) Discuss this statement: "Children from low-income populations continued to experience a higher asthma hospitalization rate than children from high-income populations in 2000."

Use Figure 1, which shows how the incidence of asthma varies over the calendar year in NYC, to discuss the following questions in class. Submit your written response to these questions in one week.

a) Analyze the graph as you learned in the classroom.
Hint: Why does the curve reach the highest point (local maxima) at certain months over the calendar year?

b) Calculate the average rate of change in the incidence of asthma between April and May.

c) Calculate the average rate of change in the incidence of asthma between May and June.

d) What is the correlation between your calculation (from b and c) with slopes of the line segments between April and May and between May and June?

e) Find the equation of the line between (April and May) in the slope y-intercept form.

Homework (to be submitted one week later)

Use the data found in the NYC booklet *Asthma Facts*: (http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf) for data showing the number of children in NYC who have been hospitalized with asthma in the last ten years (p. 11) to solve the following problems:

a. Build a table of two columns that shows the number of children in NYC who have been hospitalized with asthma (column #2) between the years 1990 and 2000 (column #1).

b. Graph the relationship between the percentage of people who have been hospitalized with asthma (y-axis) and the year (x-axis) in NYC between the years 1990 and 2000.

c. Graph the relationship between the percentage of people who have been hospitalized with asthma (y-axis) and the year (x-axis) in the US between the years 1990 and 2000.

d. Compare the two graphs. Explain why the graphs are different.
Hint: Plot both graphs in the same window

Reflection

Write one paragraph about how this math assignment and reading changed the way you think about air quality and asthma in your neighborhood in NYC. You need to use this data and reflection in your Critical Thinking wiki project.

References

- Department of Health and Human Services. (2000, Summer/Fall). *Special Issue on Geographic Information Systems*. (vol 10, number 2).
- National Library of Medicine. (2006, June). *Tox Town*. Retrieved February 12, 2009, from http://toxtown.nlm.nih.gov/text_version/chemicals.php
- Native Village. (n.d.) *How to Avoid the Top 10 Most Common Toxins*. Retrieved February 12, 2009, from http://www.nativevillage.org/Messages%20from%20the%20People/How%20to%20avoid%20environmental_toxins.htm
- New York City Department of Health and Mental Hygiene Childhood Asthma Initiative. (2003, May). *Asthma Facts*. Retrieved February 3, 2009, from http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf
- New York City Department of Health and Mental Hygiene. (2003, April). Asthma can be controlled. *NYC Vital Signs* (vol 2., number 4). Retrieved February 3, 2009, from http://www.nyc.gov/html/doh/downloads/pdf/survey/survey-2003asthma.pdf
- Scorecard: The Pollution Information Site. (2005). *Pollution locator smog and particulates*. Retrieved January 22, 2009: http://www.scorecard.org/env-releases/cap/
- United States National Library of Medicine. (2008, February 11). *ToxMap Environmental Health eMaps*. Retrieved February 12, 2009, from http://toxmap.nlm.nih.gov/toxmap/main/index.jsp

Toxic Release and Pollution: Asthma in NYC

Yasser Hassebo
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Project Quantum Leap

Objectives

The objective of this assignment is to help students gain a deeper understanding of how environmental pollutants, toxins, and dust affect daily life, particularly with regard to the increasing number of people who suffer from asthma. This objective can be achieved through activities concentrated on reading relevant materials, graphic analysis, linear function, positive and negative slopes, and other mathematical theories. Also, this assignment encourages students to recognize how the mathematical topics covered in Elementary Algebra (MAT096) are very useful for understanding the world around us.

This assignment has three stages. First, in the Motivation stage, aided by a PowerPoint presentation called "Why should we care?" the instructor discusses the sources of air pollution transportation, helping students to understand the environmental disasters in NYC including the plume-cloud event in 2004. Students read articles and web resources in preparation for class discussions on topics such as: What is asthma? How many people currently suffer from asthma in NYC and worldwide?

Next, during the Math stage, students learn to plot, calculate, and compare graphs and numbers. They practice these skills in class and through homework assignments. In the Reflection stage, students deposit in their ePortfolios their final work and their written essays about what they've learned. This process reinforces students' knowledge and use of technology (computers, scanners, the web, Microsoft Word and Excel).

Math Topics
Matrix Code: Geometric context, ordered pairs (table), graphic analysis and interpretation,linear approximation, slope calculation (positive and negative)

Tools
Multimedia projector, computer with Internet access

Comments
This very engaging project was completed in the middle of the semester. These math activities encouraged students to use and strengthen math skills learned in the classroom, and finally to understand the scale of these issues, so as to support their understanding of the world around them. Secondly, the activities reviewed the earlier class topics (linear equations, slope and ordered pairs, graphical interpretation) to prepare the student for the midterm exam.

When to Introduce
This activity should be introduced in the beginning of the 6th week of the semester

Activity Time Frame
Two weeks

Reflection

As I began to plan my pedagogical strategy, I realized that the impact of environmental pollution and global warming on health in NYC would be an engaging topic for my students, and one broad enough to use as a theme in several lessons. The Motivation stage was very successful. During my presentation, students were completely involved in the class discussion. Students were very interested in discovering, for the first time, about air pollution transportation and in learning about the plume cloud that produced dangerous chemicals in students' own neighborhoods. The majority of students read and prepared for the following week's discussion.

The next week, I introduced the second stage, Math. The mathematical activity was developed to strengthen students' understanding of graphic analysis, ordered pairs, linear equation, and slope. Another goal was to have students realize that mathematical calculations can increase their ability to comprehend what goes on in the world around them. I discussed the mathematical theories and practices in class, and gave them another week to return their final work. Students' responses were very positive. Most of the students submitted the project by the due date. The majority of students were motivated to use computers and the web to do the math calculations and to write their reflections.

Activity Overview

Motivation Stage (Attached, Parts A, B and PowerPoint, Part E) (One week)

1. I start the activity with a PowerPoint presentation about pollution transportation, sources, and scientific techniques to understand the effect of these environmental factors and disasters on human health in NYC (attached, Part E).

2. Students are provided with selected websites, where they read and collect statistical data about asthma, dust clouds, pollution transportation, and toxic chemicals in their own area in NYC, and in the US (Student Resources Handout (attached, Part A) .

3. After one week they practice asking critical questions about the reading (especially about asthma) in class. (Class Activity, attached, Part B).

Calculations Stage (Attached, Part C) (One week)

The math activities should be introduced one week after the motivation stage.

1. In class, students are given the Asthma Facts and Numbers handout (Part C).

2. For homework, students are asked to answer a set of questions about asthma in NYC and in the US. These questions were designed to encourage students to use the math skills learned in class to establish graphs and comparisons, calculate numbers from graphs, predict future values, and finally to understand the scale of these issues. This work will help them support their understanding of the problem and also help them develop critical thinking skills.

3. In the following class, students share their calculations and their reflections with each other in small groups.

Reflection (Extra Credit) (Attached, Part D)

The last stage consists of a writing assignment. Students attend events focused on the problem of asthma, read articles, and use the mathematical graphs and calculations to write a one-page essay. In the essay, students present information and their point of view about the problem of asthma. The essay must be well-organized and assertions must be supported with mathematical evidence.

In order to have students make better connections between the mathematical evidence and writing critically about this project, students are asked to write a reflective paper and post it on the LaGuardia ePortfolio to gain extra credit, thereby improving their scores (attached, Part D) .

Materials and Resources

- Handout

The following websites provide additional information on air pollution:

- Department of Health and Human Services. (2000, Summer/Fall). *Special Issue on Geographic Information Systems*. (vol 10, number 2).

- New York City Department of Health and Mental Hygiene Childhood Asthma Initiative. (2003, May). *Asthma Facts*. Retrieved February 3, 2009, from http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf

- New York City Department of Health and Mental Hygiene. (2003, April). Asthma can be controlled. *NYC Vital Signs* (vol 2, number 4). Retrieved February 3, 2009, from http://www.nyc.gov/html/doh/downloads/pdf/survey/survey-2003asthma.pdf

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- United States National Library of Medicine. (2008, February 11). *ToxMap Environmental Health eMaps*. Retrieved February 12, 2009, from http://toxmap.nlm.nih.gov/toxmap/main/index.jsp

- World Health Organization. (2009). *Asthma*. Retrieved February 3, 2009, from http://www.who.int/respiratory/asthma/en/

Handout: Asthma Facts and Numbers

Hassebo | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Part A

Research (one week)

1. Read the World Health Organization fact sheet about asthma : http://www.who.int/topics/asthma/en/
2. Read the Executive Summary of the New York City Department of Health and Mental Hygiene's pamphlet *Asthma Facts* (pages 7 & 8): http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf
3. Using your zip code, research the air quality in your neighborhood on the Scorecard: Pollution Information Site: http://www.scorecard.org/env-releases/cap/index.tcl
4. Take good notes and be prepared to discuss what you have read in class next week.

References

- Department of Health and Human Services. (2000, Summer/Fall). *Special Issue on Geographic Information Systems*. (vol 10, number 2).
- New York City Department of Health and Mental Hygiene Childhood Asthma Initiative. (2003, May). *Asthma Facts*. Retrieved February 3, 2009, from http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf
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- Scorecard: The Pollution Information Site. (2005). *Pollution locator smog and particulates*. Retrieved January 22, 2009: http://www.scorecard.org/env-releases/cap/
- United States National Library of Medicine. (2008, February 11). *ToxMap Environmental Health eMaps*. Retrieved February 12, 2009, from http://toxmap.nlm.nih.gov/toxmap/main/index.jsp
- World Health Organization. (2009). *Asthma*. Retrieved February 3, 2009, from http://www.who.int/respiratory/asthma/en/

Part B

Activity

Discuss the following questions:

a. What is asthma?

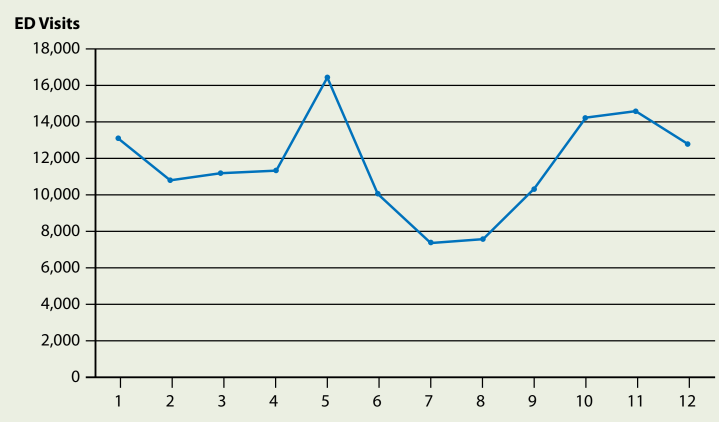
b. How many people currently suffer from asthma in NYC and worldwide?

c. How many New Yorkers were diagnosed with asthma in 2006?

d. Discuss this statement: "Children from low-income populations continued to experience a higher asthma hospitalization rate than children from high-income populations in 2000."

Use Figure 1, which shows how the incidence of asthma varies over the calendar year in NYC, to

Fig. 1: Asthma varies over the calendar year (NY)



discuss the following questions in class. Submit your written response to these questions in one week.

a. Analyze the graph as you learned in the classroom.
Hint: Why does the curve reach the highest point (local maxima) at certain months over the calendar year?

b. Calculate the average rate of change in the incidence of asthma between April and May.

c. Calculate the average rate of change in the incidence of asthma between May and June.

d. What is the correlation between your calculation (from b and c) with slopes of the line segments between April and May and between May and June?

e. Find the equation of the line between (April and May) in the slope y-intercept form.

Part C: Homework

Use the data found in the NYC Department of Health and Mental Hygiene pamphlet *Asthma Facts* (http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf) for data showing the number of children in NYC who have been hospitalized with asthma in the last ten years (p. 11) to solve the following problems:

a. Build a table of two columns that shows the number of children in NYC who have been hospitalized with asthma (column #2) between the years 1990 and 2000 (column #1).

b. Graph the relationship between the percentage of people who have been hospitalized with asthma (y-axis) and the year (x-axis) in NYC between the years 1990 and 2000.

c. Graph the relationship between the percentage of people who have been hospitalized with asthma (y-axis) and the year (x-axis) in the US between the years 1990 and 2000.

d. Compare the two graphs. Explain why the graphs are different.
Hint: Plot both graphs in the same window.

Part D

What have you learned?

Write one page about how this math assignment and the reading you did changed the way you think about air quality and asthma in your neighborhood in NYC. Consider the following questions:

1. What did you learn about different types of pollution, global warming, dust, smog, and ozone in Los Angeles and London? How do these factors affect the growth or decline in the number of people who have asthma?

2. Describe how the mathematical topics, techniques and tools helped you to develop your understanding of pollution and its effect on the number of people who have asthma.

3. In the future, how do you plan to use math in your other classes to support your arguments and consequently achieve your academic and personal goals?

4. Will this project help you to be a better student and a better learner? If so, how? If not, why not?

Enjoying Cheddar Cheese

Javier Roldan McKinley
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Project Quantum Leap

Objectives

This project helps students understand and use the nutrition facts label for food, and at the same time reinforces the concepts of (1) factoring the difference of two squares, (2) solving a quadratic equation using the square root method, and (3) solving a quadratic equation using the general formula.

Math Topics
Factorization, difference of squares, quadratic equations, zero-factor property, radicals

Purpose
Review

Comments
See Materials and Resources for the source of the information

When to Introduce
Week 11

Activity Time Frame
Three weeks

Reflection

Not only is calcium responsible for the strength of teeth and bones, but it also helps in healing wounds, contracting muscles, metabolizing fat, releasing neurotransmitters, and other functions. The main sources of calcium for humans are dairy products. After milk, cheese is the most important source of calcium for humans. However, not all the daily calcium needs can be taken from cheese because cheese also contains a great amount of saturated fat. This assignment is intended to integrate nutritional facts about cheddar cheese with geometry concepts and three methods for solving quadratic equations.

In the introductory page of the activity, students were asked to extract the nutritional data from the nutrition facts label of a food. We focused on saturated fat, a well-recognized contributor to obesity. Following this, the concept of the density of cheese was introduced and illustrations were used to help students visualize the situation prior to presenting the methods for solving quadratic equations.

In this assignment, numbers were carefully selected in an attempt to make the cheese problem amenable to math skills taught in class. Perhaps the exercise appears a little contrived, but most math educators agree that there is no natural connection between factoring and everyday life. One quadratic equation was devised such that it can be simplified to terms of perfect squares. Students can therefore solve the equation by the factoring method: specifically, factoring the difference of squares. The solution of a quadratic equation by using the square root property and by using the general formula was also reviewed in this activity. The same answer was expected to be obtained in all three cases. The three methods mentioned above can be used to solve the same quadratic equations because the linear coefficient of the quadratic equations is zero.

Since the solution of a quadratic equation leads to two answers, in each problem the students were asked to give the answer that makes sense for the real problem that the quadratic equation represents. The dimension of cheese pieces was needed; therefore the students needed to give the positive root as the unique answer to the problem in each case. Most of the students preferred the difference of squares method over the other two solution techniques. We also discussed that, if the linear coefficient is other than zero, then the general formula would be a safe method to solve the problem (a different factorization might arise in some cases). I am pleased that through this activity, students learned a very important point in solving quadratic equations: when possible, factoring is a faster and easier way to solve them. However, if the trinomial is not factorable, we must use the quadratic formula.

As a positive aspect of the activity, most of the students were interested in the food pyramid and the nutrition fact concepts. They also expressed that the geometric figures illustrating the situation helped them to visualize the problem. Most of the students were surprised when they learned how much saturated fat cheddar cheese contains, and expressed that they would be more careful about their nutrition in the future. I believe that after this activity, they can easily relate serving sizes and the saturated fat contained in foods. Students found the activity to be somewhat unconventional but very helpful for reviewing factorization and quadratic equations.

Activity Overview

I recommend introducing this activity in the eleventh week of the semester; one week is given to students to complete it.

Week 11 (15 minutes in class): Distribute the activity packet. Briefly describe the issues related to the food pyramid, nutrition facts, saturated fat, and calcium. Students should fill in the lines on the first page of the handout by extracting information about the nutrition facts from Figure 1(b). All necessary information is included in the four-page handout given to the students. Ask students to read the activity carefully at home.

Week 12, Day 1 (15 minutes in class): Give the students the opportunity to ask questions about the reading assignment. Remind them that office hours are available to answer additional questions, and that they must complete item 5 on page 4, to summarize their understanding of the activity.

Week 12, Day 2: Collect the assignment.

Week 13 (15 minutes): A short class discussion takes place the day the graded assignments are given back to the students.

Materials and Resources

- Handout
- Class notes and textbook
- Condé Net Nutrition Data Know What You Eat. (2008). *Cheese, cheddar*. Retrieved February 3, 2009, from http://www.nutritiondata.com/facts/dairy-and-egg-products/8/2
- Harvard School of Public Health. (2009). *The nutrition source healthy eating pyramid*. ©2008 Harvard University. Retrieved February 3, 2009, from www.hsph.harvard.edu/nutritionsource/what-should-you-eat/pyramid/
- Mipiramid.org. (2009). Retrieved February 12, 2009, from http://www.mipiramid.org/
- Natural Ways to Health. (n.d.) *Calcium – nutritional health information*. Retrieved February 2, 2009, from http://www.naturalways.com/calciumResearch.htm
- Oregon State University Linus Pauling Institute Micronutrient Research for Optimum Health. (2009). *Micronutrient information center.* Retrieved February 3, 2009, from http://lpi.oregonstate.edu/infocenter/minerals/calcium/

Handout: Enjoying Cheddar Cheese

McKinley | Elementary Algebra – Problems and Issues in Public Health (MAT096)

The goal of this activity is to determine how many pieces of cheddar cheese you can eat without exceeding the average recommended daily fat requirement. This task requires the skill of solving quadratic equations. Through a set of exercises, you will apply several problem-solving strategies to a real-life situation.

Among dairy products, cheese is an important component of human nutrition. It is placed at the upper levels of the food pyramid in the "Dairy or Calcium Supplement" level; see Figure 1(a). Calcium is the most abundant mineral in the body. As listed on the Natural Ways to Health website, the main functions of calcium in the human body are:

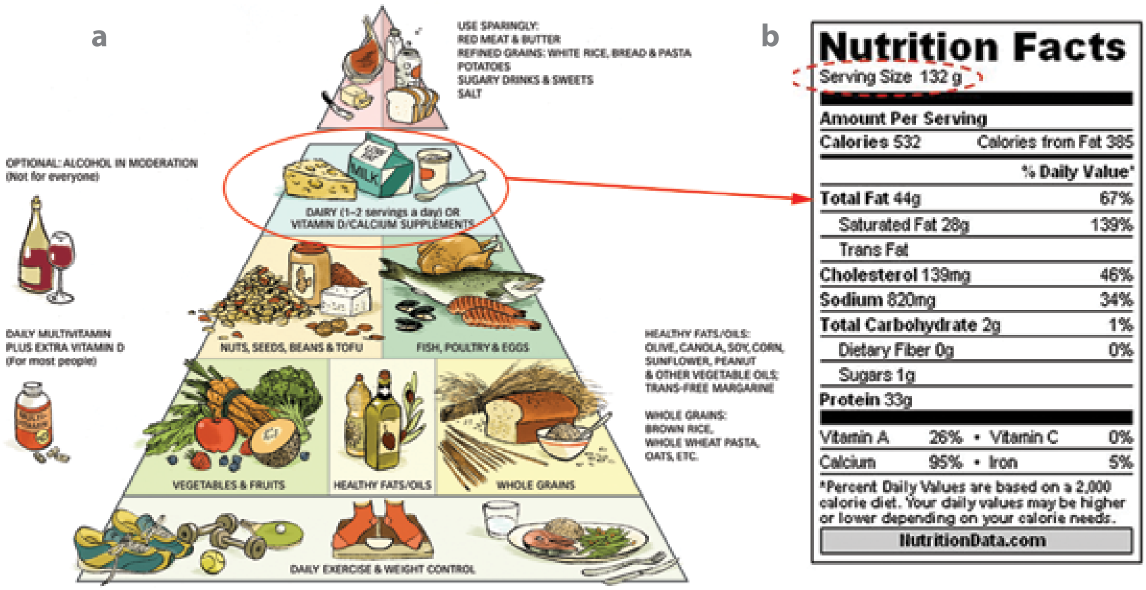
- Calcium is responsible for construction, formation, and maintenance of bone and teeth. This function helps reduce the occurrence of osteoporosis.
- Calcium is a vital component in blood clotting systems and also helps in wound healing.
- Calcium helps to control blood pressure, nerve transmission, and the release of neurotransmitters.
- Calcium is an essential component in the production of enzymes and hormones that regulate digestion, energy, and fat metabolism.
- Calcium helps to transport ions (electrically charged particles) across membranes.
- Calcium is essential for muscle contraction.
- Calcium assists in maintaining all cells and connective tissues in the body.
- Calcium may help reduce the incidence of premature heart disease, especially if adequate intakes of magnesium are also maintained.
- Calcium may help to prevent periodontal disease (gum disease).

Source: Natural Ways to Health. (n.d.) *Calcium – nutritional health information*. Retrieved February 2, 2009, from http://www.naturalways.com/calciumResearch.htm

For more information, consult the Natural Ways to Health website: www.naturalways.com, or the Oregon State University Linus Pauling Institute Micronutrient Research for Optimum Health website: http://lpi.oregonstate.edu/infocenter/minerals/calcium/ .

While cheese contains calcium necessary in our diet, it also contains fat, to which most people need to be alert. Let us imagine that you are attending a social activity, and plenty of cheddar cheese is served. How do you enjoy a wonderful event, yet keep your fat consumption in check? Do you eat too much cheddar cheese?

Figure 1 (a) Food pyramid, (b) Nutrition facts about cheddar cheese, based on a 2000 calories/day diet.



© 2008 Harvard University

Figure 1(b) presents the cheddar cheese nutrition facts and provides information on what the Surgeon General and nutritionists recommend in order to maintain a healthy, nutritious diet (based on a maximum daily consumption of 2000 calories per day). Examine Figure 1(b) and complete the sentences below by filling in the blanks:

- What is the serving size? (in grams) _________g
- How many calories are there per serving? _________
- How much calcium do you ingest in one serving? (in percentage) _________%
- How much saturated fat do you ingest in one serving? (in percentage) _________%
- How much saturated fat do you ingest in one serving? (in grams) _________g

Before making the connection between quadratic equations and cheddar cheese, you must understand the concepts of density and volume. Density is defined as the ratio of the mass to the volume that the mass occupies. The average density of the piece of cheddar cheese is about

$16 = \frac{g}{in^3}$ (grams per cubic inch). This value will allow you to estimate the amount of cheese you can eat before reaching the recommended daily limit of fat consumption. For instance, if 2 in^3 (two cubic inches) of cheese were consumed, then the amount of grams eaten is

$2\ in^3 \times 16\frac{g}{in^3} = 32g.$

Typically, cheddar cheese has a thickness of ½ inch, as depicted in Figure 2. The serving size 132 g in Figure 1 (b) refers to approximately 1 cup of diced cheese, which is certainly too much for most people to eat during a social activity. Indeed, there are 44 g of fat in that portion, which is 67% of the recommended daily value.

Let us assume that you decide to eat, say 50 g of cheese in four pieces, as illustrated in Figure 3. How do you cut the cheese to obtain this amount?

Figure 2 Pre-cut cheddar cheese block.

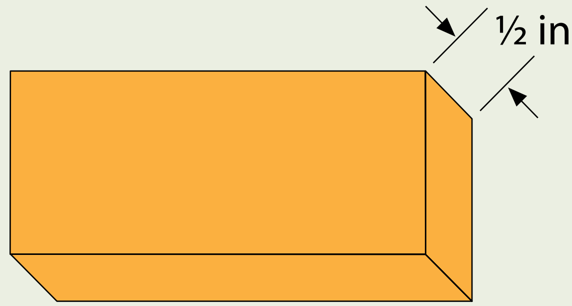
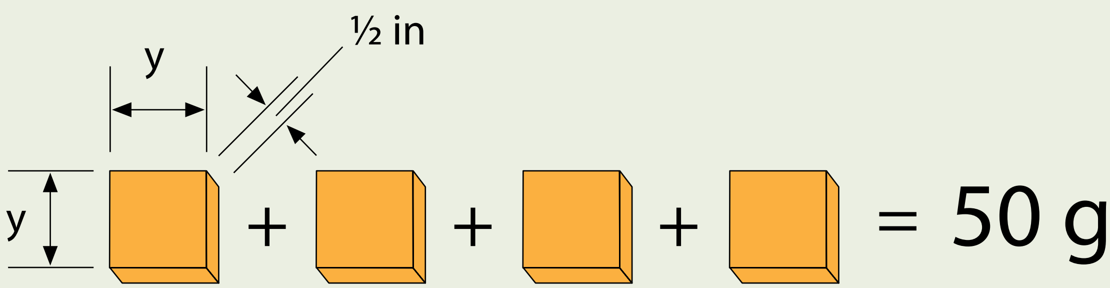


Figure 3 Four pieces of cheese adding up 50 g.



Recall that mass is the product of density and volume. The volume of each piece of cheese is $\boldsymbol{y} \times \boldsymbol{y} \times \frac{1}{2}$ in, see Figure 3, where $\boldsymbol{y}$ is given in inches. For cheddar cheeses, the density is $16\frac{g}{in^3}$; then the mass of each piece is $\boldsymbol{y} \times \boldsymbol{y} \times \frac{1}{2}\,\text{in} \times 16\frac{g}{in^3}$, and the mass of 4 pieces is equated to the 50 g of cheese you decided to eat.

$$4 \times \boldsymbol{y} \times \boldsymbol{y} \times \frac{1}{2}\,\text{in} \times 16\frac{g}{in^3} = 50\text{g} \quad (1),$$

which after simplification and rearrangement can be written as

$$32\boldsymbol{y}^2 - 50 = 0 \quad (2).$$

1. In the space below, solve Equation (2) by using the difference of squares method. *Choose the value of* **y** *that makes sense with the problem.*

2. In the space below, solve Equation (2) by using the square root property. *Choose the value of* **y** *that makes sense with the problem.*

3. Of course, Equation (2) is also solvable by using the general formula. In the space below,

use the quadratic formula to solve Equation (2). Clearly identify the coefficients ***a***, ***b***, and ***c***. *Choose the value of* y *that makes sense with the problem.*

Final Remarks

4. The results obtained in cases 1, 2, and 3 have to be same since you solved the same equation in each case; you just used a different solution technique each time. Each piece is $\frac{5}{4}$ in by $\frac{5}{4}$ in by $\frac{1}{2}$ in; this is 1.25 in by 1.25 in by 0.5 in. Four pieces of this size are what you should eat at any social activity where cheese is served. The four pieces add up to 50 grams of cheese, which would provide you with about 36% of your daily calcium needs, but will also supply 53% of your daily need for saturated fat, which is quite a lot in one single snack.

5. Perhaps nobody would actually solve a quadratic equation before eating cheese during a social event, but the calculations that you have just performed would awaken you to the great amounts of fat that might be contained in basic foods. In the space below, please write a script describing your learning from this activity. You must incorporate the following:

   a. The nutritional benefit of cheese.

   b. The danger of cheese overconsumption.

   c. How to avoid cheese overconsumption using math.

   d. What mathematical skills are used in solving this problem?

References

- Condé Net Nutrition Data Know What You Eat. (2008). *Cheese, cheddar*. Retrieved February 3, 2009, from http://www.nutritiondata.com/facts/dairy-and-egg-products/8/2
- Harvard School of Public Health. (2009). *The nutrition source healthy eating pyramid*. ©2008 Harvard University. Retrieved February 3, 2009, from www.hsph.harvard.edu/nutrition-source/what-should-you-eat/pyramid/
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Genomics and Its Impact on Science and Society

Frank Wang
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Project Quantum Leap

Objectives

News on genetic research has been intensely covered by the media in recent years. There are many potential benefits of genetic research, but also some societal concerns arising from the new genetics. This activity introduces the terminology and basic concepts of biotechnology. Mathematically, the rules of exponents are emphasized.

Math Topics
Exponents

Purpose
Motivation

Comments
This assignment has three parts, and takes two class periods to complete

When to Introduce
Week 4, in conjunction with introducing exponents and polynomials

Activity Time Frame
One hour divided between two class periods, and reading assignment as homework

Reflection

In our lifetime, we will make many important private and public decisions that require understanding of current biological research. For example, gene testing promises to diagnose and confirm disease, provide prognostic information about the course of disease, and predict the risk of future disease in healthy individuals or their progeny. In the process of learning about biological research in today's world, related ethical questions arise, such as: who owns and controls genetic information? How does personal genetic information affect self-identity and society's perceptions? As educators, we have the responsibility to make the latest research results accessible to our students, and to provide them with the scientific foundation for considering the broad societal impact of genetic research.

The double helix structure of DNA has become an icon of modern science. Part I of the activity offers students the opportunity to learn that the four-letter alphabet (A, T, G, C) for DNA is sufficient for the diversity of life, thanks to the rules of exponents. The math concept is not hard to understand, but the details of protein synthesis require much more time to explain. A one-hour lesson will only provide a brief introduction to these concepts. If an instructor intends to adopt this activity, he or she should stress how math is used in biological research, and hopefully some students will be interested in pursuing further study.

Part II is inspired by Richard Dawkins' influential *The Selfish Gene*. Dawkins has a unique gift for explaining a concept so that the reader feels it in the marrow of his or her bones. Genetic relatedness is one such example. As one will see in the handout, two first cousins share 1/8 of the same genes. For relationships as distant as third cousins, only 1/128 of the genes are common, which is essentially the same as for any random individual. A humorous but practical exercise in this part of activity is to decline a relative's request for a favor based on math; see the handout. I highly encourage instructors to read *The Selfish Gene,* and instructors should encourage their students to do so too.

Part III is concerned with DNA as legal evidence. After performing a simple calculation using the properties of exponents, students need to use their number sense to decide whether a prosecutor's claim is logical.

Some problems can be solved from common sense, but this approach can become inadequate when one encounters a more complex situation. Part II illustrates that math is useful in developing an algorithm, so that one can follow a procedure to solve a problem, which is typically much faster than calculating from first principles. However, students need to pay close attention to the assumptions on which an algorithm is based, rather than blindly executing the procedure. Both the second and third parts alert students that a model is usually simplified, and one needs to be aware of the limitation of the model.

Activity Overview

This activity should be implemented in the fourth week, when Chapter 4 (Exponents and Polynomials) is introduced. There are three parts in this activity.

1. In the first 30-minute in-class session, the instructor should distribute the handout and discuss how genetic research will impact our society. After doing so, "Genomics and Its Impact on Science and Society (Part I)" should be worked out in class.
2. Students will be asked to read the excerpt of *The Selfish Gene,* which is in Part II of the handout, after class (for homework).
3. At the next class (after students have read Part II), the instructor will guide them as they perform some calculations of genetic relatedness.
4. During the third class, students will read and discuss the material in Part III. The instructor will use DNA evidence to strengthen students' understanding of the rules of exponents.
5. Students should be encouraged to find out more about biological research through the readings and Internet resources; information in the Resources section should be useful.

Materials and Resources

- Handout
- Reading: Excerpt from Dawkins, R. (1989). *The Selfish Gene*. Oxford: Oxford University Press. (p. 90–93, 98).
- Solutions to questions and exercises
- Devlin, K., & and Lorden, G. (2007). *The Numbers Behind NUMB3RS*. New York: Plume.
- Devlin, K. (2006, September). Statisticians not wanted. *The Mathematical Association of America*. Retrieved February 4, 2009, from: http://www.maa.org/devlin/devlin_09_06.html
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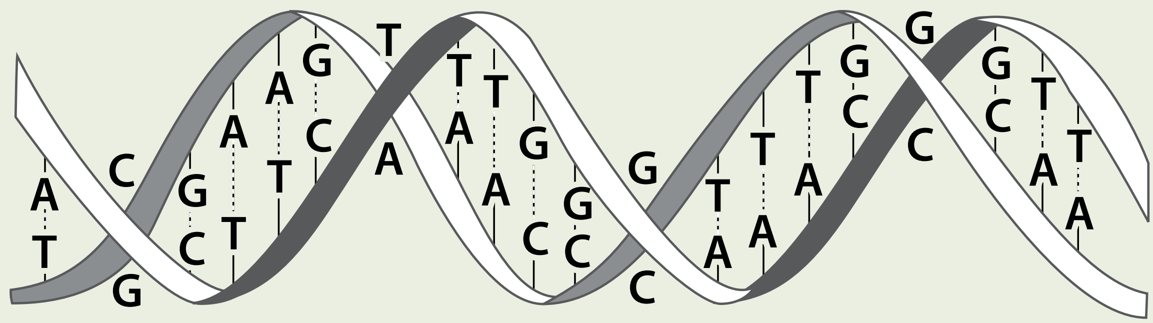
- Ridley, M. (1999). *Genome: The Autobiography of a Species in 23 Chapters*. New York: Harper Collins.

Handout: Genomics and Its Impact on Science and Society

Wang | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Part I



Source: http://apimba.org/images/Double%20helix.gif

The genome is an organism's complete set of DNA. The DNA molecule has a double-helix structure, first discovered by James Watson and Francis Crick in 1953, based on the x-ray evidence obtained by Rosalind Franklin.

Imagine that the genome is a book. (Ridley, 1999, p.6)

There are twenty-three chapters, called CHROMOSOMES.

Each chapter contains several thousand stories, called GENES.

Each story is made up paragraphs, called EXONS, which are interrupted by advertisements, called INTRONS.

Each paragraph is made up of words, called CODONS.

Each word is written in letters, called BASES.

DNA from all organisms is made up of the same chemical and physical components. The DNA sequence is the particular side-by-side arrangement of bases along the DNA strand. The central dogma of molecular biology states that the flow of information follows the direction:

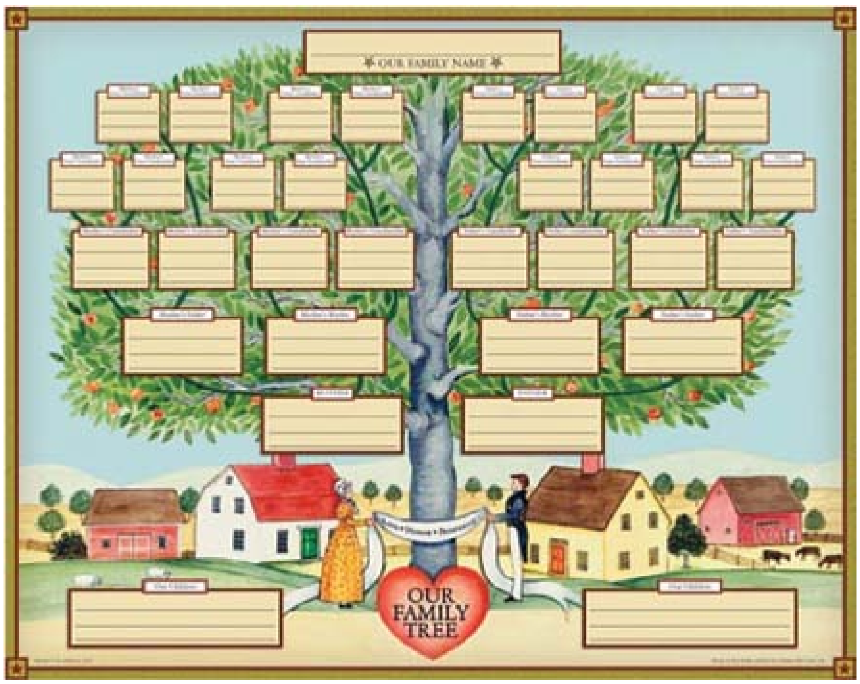
DNA $\rightarrow$ RNA $\rightarrow$ proteins.

The four-letter alphabet, A, T, G, C for DNA has an equivalent A, U, G, C for RNA. There are 20 common forms of amino acids basic to living systems, 21 if one counts the kind found only in the brain.

Questions

1. Four different RNA bases (A, C, G, and U) read three at a time. How many distinct combinations can a triplet of four bases form?
2. Since there are only 20 different kinds of amino acid, argue that the vocabulary of the triplet code is more than sufficient to give each different amino acid a different specification.
3. Use your dictionary to find out what the difference is between RNA and NRA.

Part II: Genomics and Its Impact on Science and Society



Source: http://www.zanowski.net/images/family-tree2.jpg

Preliminary question:
Every person has two (2) biological parents (they may not have been married), and four (4) grandparents. Therefore, one has eight (8) great-grandparents, and sixteen (16) second great-grandparents. How many third, fourth, and fifth great-grandparents do you have?

This simple example shows that the number of your ancestors increases rapidly. Indeed, you should have more than one million 18th great-grandparents! Find out the exact number.

You might think that everyone is your relative, say your 29th cousin. But how close are you? In the influential book *The Selfish Gene,* Richard Dawkins defined close relatives as two individuals who have a greater than average chance of sharing genes. He described a way to determine "relatedness" with some math.

Read the attached excerpt from Dawkins.

Exercise

1. Calculate the relatedness between you and your nephew.

2. Calculate the relatedness between you and your second cousin.

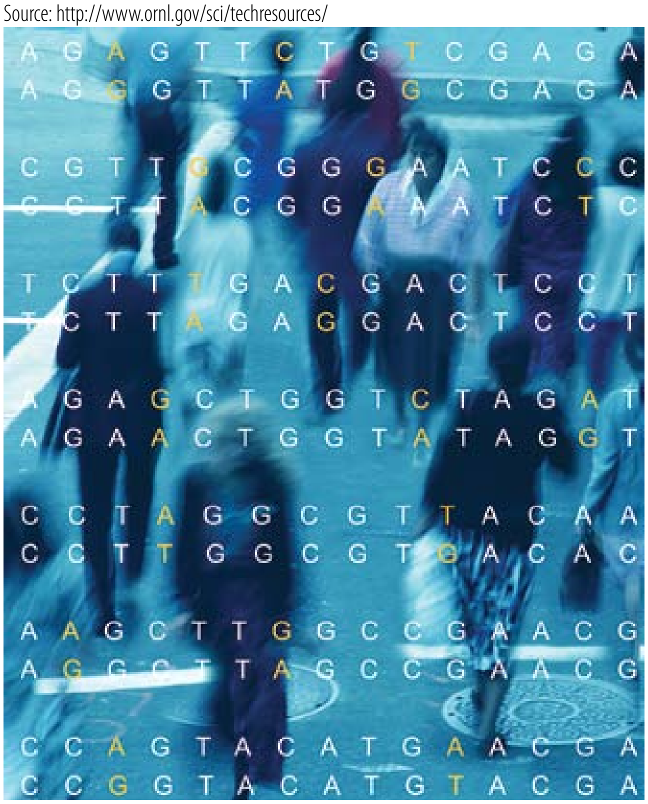
3. Calculate the relatedness between you and your half uncle.

Reflection

Imagine a situation in which your third cousin asks to borrow money from you, claiming "blood is thicker than water." Write a concise essay to decline his or her request, based on the math you have learned.

Part III: Genomics and Its Impact on Science and Society

Source: http://www.ornl.gov/sci/techresources/



Human_Genome/publicat/primer2001/primer11.pdf, p. 9

Read the following excerpt from "Statisticians not wanted," by Keith Devlin. For interested students, the entire article is available online from the Mathematical Association of America (MAA) Online website.

Source: Devlin, K. (2006, September). Statisticians not wanted. *The Mathematical Association of America*. Retrieved February 4, 2009, from: http://www.maa.org/devlin/devlin_09_06.html

> When two randomly chosen DNA samples match completely in a large number of regions, such as the 13 used in the FBI's system, the probability that they could have come from two unrelated people is very small. This fact makes DNA identification extremely reliable (when performed correctly). The degree of reliability is generally measured by using the product rule of probability theory to determine the likelihood of finding a particular profile among a random selection of the population.
>
> For example, consider a profile based on just three sites. The probability that someone would match a random DNA sample at any one site is roughly one in ten (1/10). So the probability that someone would match a random sample at three sites would be about one in a thousand:
>
> $1/10 \times 1/10 \times 1/10 = 1/1{,}000.$
>
> Applying the same probability calculation to all 13 sites used in the FBI's CODIS

system would mean that the chances of matching a given DNA sample at random in the population are about one in ten trillion:

$(1/10)^{13} = 1/10{,}000{,}000{,}000{,}000$.

This figure is known as the random match probability (RMP). Since it is computed using the product rule for multiplying probabilities, it assumes that the patterns found in two distinct sites are independent. Is this assumption justified? Personally, I find this a particularly worrying assumption, and it very definitely is an assumption, but genetics is not my area of expertise, and (unlike the California Supreme Court) I do not feel comfortable stepping into the specialties of other professionals. Overall those specialists seem reasonably confident in the independence assumption. In any event, the courts regularly accept the independence assumption, and my present focus lies elsewhere, so for the purpose of this essay, I'll simply accept it too.

Discussion

When a prosecutor claims that the probability of accidental DNA mismatch is

1/15,000,000,000,000,000

or 1 in 15 quadrillion, will you accept his or her statement (based on mathematical reasoning)?

References

- Dawkins, R. (1989). *The Selfish Gene*. Oxford: Oxford University Press.
- Devlin, K., & and Lorden, G. (2007). *The Numbers Behind NUMB3RS*. New York: Plume.
- Devlin, K. (2006, September). Statisticians not wanted. *The Mathematical Association of America*. Retrieved February 4, 2009, from: http://www.maa.org/devlin/devlin_09_06.html
- Office of Biological and Environmental Research of the U.S. Department of Energy Office of Science. (2003). *Genomics and its impact on science and society*. Retrieved January 28, 2009, from http://www.ornl.gov/sci/techresources/Human_Genome/publicat/primer2001/primer11.pdf
- Ridley, M. (1999). *Genome: The Autobiography of a Species in 23 Chapters*. New York: Harper Collins.

Reading: *The Selfish Gene*

Wang | Elementary Algebra – Problems and Issues in Public Health (MAT096))

Source: Dawkins, R. (1989). *The Selfish Gene*. Oxford: Oxford University Press. (p. 90–93, 98).

Suppose you contain one copy of the gene *G*. You must have received it either from your father or from your mother (for convenience we can neglect various infrequent possibilities – that *G* is a new mutation, that both your parents had it, or that either of your parents had two copies of it). Suppose it was your father who gave you the gene. Then every one of his ordinary body cells contained one copy of *G*. Now you will remember that when a man makes a sperm he doles out half his genes to it. There is therefore a 50 per cent chance that the sperm that begot your sister received the gene *G*. If, on the other hand, you received *G* from your mother, exactly parallel reasoning shows that half of her eggs must have contained *G*; once again, the chances are 50 per cent that your sister contains *G*. This means that if you had 100 brothers and sisters, approximately 50 of them would contain any particular rare gene that you contain. It also means that if you have 100 rare genes, approximately 50 of them are in the body of any one of your brothers or sisters.

You can do the same kind of calculation for any degree of kinship you like. An important relationship is that between parent and child. If you have one copy of gene *H*, the chance that any particular one of your children has it is 50 per cent, because half your sex cells contain *H*, and any particular child was made from one of those sex cells. If you have one copy of gene *J*, the chance that your father also had it is 50 per cent, because you received half your genes from him, and half from your mother. For convenience we use an index of *relatedness*, which expresses the chance of a gene being shared between two relatives. The relatedness between two brothers is ½, since half the genes possessed by one brother will be found in the other. This is an average figure: by the luck of the meiotic draw, it is possible for particular pairs of brothers to share more or fewer genes than this. The relatedness between parent and child is always exactly ½.

It is rather tedious going through the calculations from first principles every time, so here is a rough and ready rule for working out the relatedness between any two individuals *A* and *B*. You may find it useful in making your will, or in interpreting apparent resemblances in your own family. It works for all simple cases, but breaks down where incestuous mating occurs, and in certain insects, as we shall see.

First identify all the common ancestors of *A* and *B*. For instance, the common ancestors of a pair of first cousins are their shared grandfather and grandmother. Once you have found a common ancestor, it is of course logically true that all his ancestors are common to *A* and *B* as well. However, we ignore all but the most recent common ancestors. In this sense, first cousins have only two common ancestors. If *B* is a lineal descendant of *A*, for instance his great grandson, then *A* himself is the 'common ancestor' we are looking for.

Having located the common ancestor(s) of *A* and *B*, count the generation distance as follows. Starting at *A*, climb up the family tree until you hit a common ancestor, and then climb down again to *B*. The total number of steps up the tree and then down again is the generation distance. For instance, if *A* is *B*'s uncle, the generation distance is 3. The common ancestor is *A*'s father (say) and *B*'s grandfather. Starting at *A* you have to climb up one generation in order to hit the common ancestor. Then to get down to *B* you have to descend two generations on the other side. Therefore the generation distance is $1 + 2 = 3$.

Having found the generation distance between *A* and *B* via a particular common ancestor, calculate that part of their relatedness for which that ancestor is responsible. To do this, multiply *J* by itself once for each step of the generation distance. If the generation distance is 3, this means calculate $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$ or $(\frac{1}{2})^3$. If the generation distance via a particular ancestor is equal to g steps, the portion of relatedness due to that ancestor is $(\frac{1}{2})^g$.

But this is only part of the relatedness between *A* and *B*. If they have more than one common ancestor we have to add on the equivalent figure for each ancestor. It is usually the case that the generation distance is the same for all common ancestors of a pair of individuals. Therefore, having worked out the relatedness between *A* and *B* due to any one of the ancestors, all you have to do in practice is to multiply by the number of ancestors. First cousins, for instance, have two common ancestors, and the generation distance via each one is

4. Therefore their relatedness is $2 \times (1/2)^4 = 1/8$. If *A* is *B*'s great-grandchild, the generation distance is 3 and the number of common 'ancestors' is 1 (*B* himself), so the relatedness is $1 \times (1/2)^3 = 1/8$. Genetically speaking, your first cousin is equivalent to a greatgrandchild. Similarly, you are just as likely to 'take after' your uncle (relatedness $= 2 \times (1/2)^3 = 1/4$) as after your grandfather (relatedness $= 1 \times (1/2)^2 = 1/2$).

For relationships as distant as third cousin ($2 \times (1/2)^8 = 1/128$) we are getting down near the baseline probability that a particular gene possessed by *A* will be shared by any random individual taken from the population. A third cousin is not far from being equivalent to any old Tom, Dick, or Harry as far as an altruistic gene is concerned. A second cousin (relatedness = 1/32) is only a little bit special; a first cousin somewhat more so (1/8). Full brothers and sisters, and parents and children are very special (1/2), and identical twins (relatedness = 1) just as special as oneself. Uncles and aunts, nephews and nieces, grandparents and grandchildren, and half brothers and half sisters, are intermediate with a relatedness of 1/4 (Dawkins, 90–93).

Estimates of relatedness are also subject to error and uncertainty. In our over-simplified calculations so far, we have talked as if survival machines know who is related to them, and how closely. In real life such certain knowledge is occasionally possible, but more usually the relatedness can only be estimated as an average number. For example, suppose that *A* and *B* could equally well be either half brothers or full brothers. Their relatedness is either 1/4 or 1/2, but since we do not know whether they are half or full brothers, the effectively usable figure is the average, 3/8. If it is certain that they have the same mother, but the odds that they have the same father are only 1 in 10, then it is 90 per cent certain that they are half brothers, and 10 per cent certain that they are full brothers, and the effective relatedness is $1/10 \times 1/2 + 9/10 \times 1/4 = 0.275$ (Dawkins, 98).

Solutions

Part I Questions

1. Four different RNA bases (A, C, G, and U) read three at a time. How many distinct combinations can a triplet of four bases form?

   Answer: $4 \times 4 \times 4 = 4^3 = 64$

2. Since there are only 20 different kinds of amino, argue that the vocabulary of the triplet code is more than sufficient to give each different amino acid a different specification.

   Answer: The reason in part is that there are 20 different amino acids, and 64 different combinations possible in a codon (see the answer for Question 1). Indeed, the genetic code is redundant: in selecting among 20 amino acids, there are 64 possible combinations.

3. Use your dictionary to find out what the difference is between RNA and NRA.

   Answer: RNA means ribonucleic acid, while NRA means National Rifle Association. They are totally different.

Part II Preliminary questions

1. Every person has two (2) biological parents (they may not have been married), and four (4) grandparents. Therefore, one has eight (8) great grandparents, and sixteen (16) second great grandparents. How many third, fourth, and fifth great grandparents do you have?

   Answer: There are 16 second great grandparents, as stated in the question. Therefore, there are $16 \times 2 = 32$ third great grandparents, $32\times 2 = 64$ fourth great grandparents, and $64 \times 2 = 128$ fifth great grandparents.

   When it comes to 18th great grandparents, let us be more systematic. The above calculations can be restated as the following. There are 2^5 third great grandparents, 2^6 fourth great grandparents, and 2^5 fifth great grandparents. By induction, we figure that there are 2^{20} 18th great grandparents. Using a calculator, we evaluate $2^{20} = 1{,}048{,}576$.

Part II Exercises

1. Calculate the relatedness between you and your nephew.

   Answer: The common ancestors of you and your nephew are your parents (who are your nephew's grandparents). You climb up 1 generation to reach your parents, then descend 2 generations to reach your nephew. The relatedness is

   $$2 \times \left(\frac{1}{2}\right)^{1+2} = 2 \times \left(\frac{1}{2}\right)^{3} = \frac{1}{4}$$

2. Calculate the relatedness between you and your second cousin.

   Answer: Second cousins share the same great grandparents; they are 3 generations up. You climb up 3 generations, then descend 3 generations. The relatedness is

   $$2 \times \left(\frac{1}{2}\right)^{3+3} = 2 \times \left(\frac{1}{2}\right)^{6} = \frac{1}{32}$$

3. Calculate the relatedness between you and your half uncle.

Answer: Half uncle means that he is one of your parents' half brother, thus he shares only one common ancestor with one of your parents. The number of common ancestors of yours and your half uncle's is 1. You climb up 2 generations to that ancestor, then descend 1 generation to your half uncle. The relatedness is

$$1 \times \left(\frac{1}{2}\right)^{1+2} = 2 \times \left(\frac{1}{2}\right)^{3} = \frac{1}{8}$$

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The Eye and Eyeglasses

Frank Wang
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

Many students wear glasses or contact lenses. The optical power of a lens, measured in diopters (used by optometrists and ophthalmologists), is the reciprocal of the focal length. This exercise is designed to make students appreciate the connection between math and everyday life. Through manipulating the lens equation, students acquire knowledge of rational expressions and complex fractions.

Math Topics
Rational expressions, complex fractions

Purpose
Motivaton

When to Introduce
Week 8

Activity Time Frame
Thirty minutes in class

Reflection

Although it is difficult to find situations in which the knowledge of complex fractions is crucial, the lens equation offers such a possibility, at least as an introduction. It is easy to demonstrate how the lens bends light to form an image, using online Java applets, and students generally develop the basic ideas of geometric optics. Students are typically very engaged when asked to measure their own "near point" (the closest distance for which one can read the page), and this simple experiment helps students to connect the theory to practice. Once students are motivated, the instructor can demonstrate the usefulness of the lens equation, and guide students to practice rational expression manipulation. After this activity, the instructor might want to continue to work out additional exercises from the textbook.

Activity Overview

The instructor should give the handout to students, and if possible ask them about their eyeglass prescriptions. The following steps might help the instructor who intends to adapt this activity.

1. It will be ideal if the lesson is given in a computer lab, so students can experiment with the Java applet while reading the handout. If the lesson is taught in a room with a projector, the teacher can ask students to read for five minutes, and then use the Java applet to demonstrate how the lens bends the light. At this point, the instructor might ask students to read the text again so they would better understand and appreciate the underlying physical principles.

2. Students should be given about five minutes to find their own near points. The instructor is advised to bring some rulers, because most students will probably come to classroom without one.

3. As with textbook examples, the instructor should show three sample calculations.

4. Depending on the available time, students might answer the questions in the handout either in class or after class.

5. After collecting students' answers, the instructor then distributes the Solution Sheet.

Materials and Resources

- Handout #1: Sample Calculations
- Handout #2: Solutions
- Reading: Serway, R. & Jewett, J. (2008). *Physics for Scientists and Engineers* (7th ed.). Florence: Brooks Cole. 1033–1035.
- For a Java applet to demonstrate how a lens bends light, see: Hwang, F. (2004, January 29). Thin lens (converging/diverging lens/mirrors). *The NTNUJAVA Virtual Physics Laboratory*. Retrieved February 4, 2009, http://www.phy.ntnu.edu.tw/ntnujava/index.php?topic=48
- Rulers

Handout #1: Sample Calculations

Wang | Elementary Algebra – Problems and Issues in Public Health (MAT096)

After you have read the Preliminary Reading adapted from Serway & Jewett, perform the calculations below.

1. Professionals prescribe lenses of power P measured in a diopters, which is related to the focal length f (in meters) by

$$P = \frac{1}{f}$$

For a converging lens of focal length +20 cm, we convert +20 cm to +0.2 m. Therefore,

$$P = \frac{1}{0.2} = 5.0 \text{ diopters.}$$

For a diverging lens of focal length –40 cm, we convert –40 cm to –0.4 m, and obtain

$$P = \frac{1}{-0.4} = -2.5 \text{ diopters.}$$

2. A converging lens has a focal length of 10.0 cm. An object is placed 30.0 cm from the lens. Find the image distance.

Solution: The lens equation is

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

Substitute given values into the lens equation,

$$\frac{1}{10} + \frac{1}{q} = \frac{1}{30}$$ we obtain the solution $q = 15$ (cm).

3. For the above problem in a general setting, we can also manipulate the lens equation to obtain a formula for:

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \quad \blacktriangleright \quad \frac{1}{q} = \frac{1}{f} - \frac{1}{p} \quad \blacktriangleright \quad q = \frac{pf}{p - f}$$

Questions

1. Over-the-counter reading glasses are typically rated at +1.00 to +3.00 diopters. Calculate the focal lengths (in cm) of reading glasses of (a) +1.00 diopter; (b) +2.00 diopters, and (c) +2.5 diopters.

2. A converging lens has a focal length of 20.0 cm. Locate the image for object distances of (a) 40.0 cm, (b) 20.0 cm, and (c) 10.0 cm.

3. The eyes of an elderly person have near points of 70 cm. What must the focal length of corrective lenses be in order for this person to read a book at a distance of 30 cm? What is the power of the lens in diopters?

Hint: The eyes and eyeglasses together can be considered a compound lens system. For a compound lens system made of two lenses, the focal length is given by

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{f}$$

Handout #2: Solutions

Wang | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Solutions

1. Over-the-counter reading glasses are typically rated at +1.00 to +3.00 diopters. Calculate the focal lengths (in cm) of reading glasses of (a) +1.00 diopter; (b) +2.00 diopters, and (c) +2.5 diopters.

   Answer:

   a) $f = \dfrac{1}{p} = \dfrac{1}{1} = 1$ meters.

   b) $f = \dfrac{1}{p} = \dfrac{1}{2} = 0.5$ meters.

   c) $f = \dfrac{1}{p} = \dfrac{1}{2.5} = 0.4$ meters.

2. A converging lens has a focal length of 20.0 cm. Locate the image for object distances of (a) 40.0 cm, (b) 20.0 cm, and (c) 10.0 cm.

   Answer:

   a) $\dfrac{1}{40} + \dfrac{1}{q} = \dfrac{1}{20}$, $q = 40$ cm.

   b) $\dfrac{1}{20} + \dfrac{1}{q} = \dfrac{1}{20}$, $\dfrac{1}{q} = 0$, q is undefined.

   c) $\dfrac{1}{10} + \dfrac{1}{q} = \dfrac{1}{20}$, $q = -20$ cm.

3. The eyes of an elderly person have near points of 70 cm. What must the focal length of corrective lenses be in order for this person to read a book at a distance of 30 cm? What is the power of the lens in diopters?

   Answer:
   We can prove that the focal length of the combination of two thin lenses is given by

   (1) $\dfrac{1}{f} = \dfrac{1}{f_1} + \dfrac{1}{f_2}$. For uncorrected eyes, $\dfrac{1}{70} + \dfrac{1}{q} = \dfrac{1}{f_1}$

   where q is the distance between the pupil and the retina, and f_1 the focal length of the crystalline lens. For corrected eyes,

   (2) $\dfrac{1}{30} + \dfrac{1}{q} = \dfrac{1}{f} = \dfrac{1}{f_1} + \dfrac{1}{f_2}$ where f_2 is the focal length of corrective lenses.

   From (1) and (2), we solve for f_2, which is

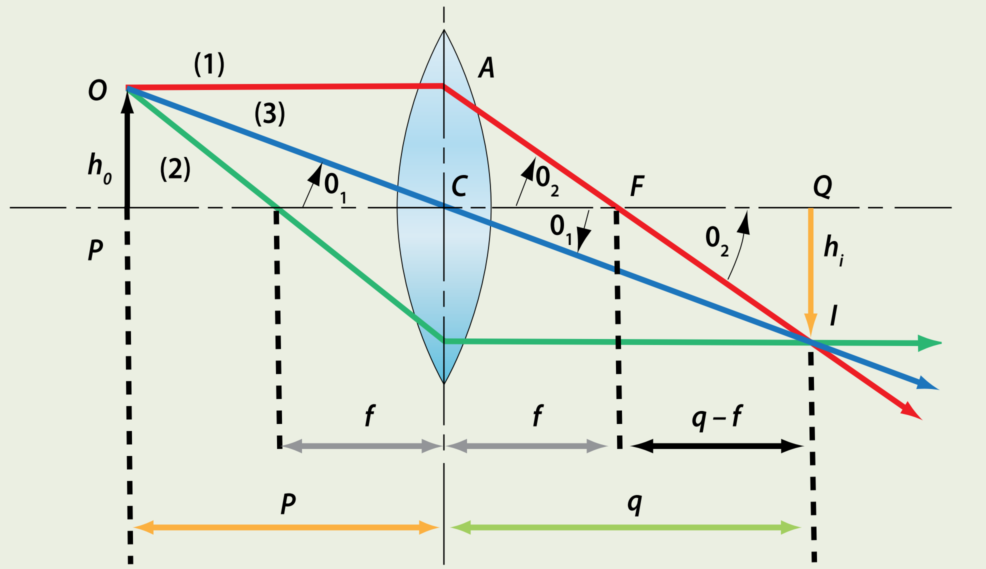
   $\dfrac{105}{2} = 52.2$ (cm). In terms of power, $p = \dfrac{1}{0.525} \cong 1.905$ (diopters).

Reading: How Eyes and Lenses Work

Wang | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Source: Serway, R. & Jewett, J. (2008). *Physics for Scientists and Engineers,* Seventh Edition. Florence: Brooks Cole. Pages 1033–1035.

Figure 1: An ideal lens bends light according the lens equation 1/*p* + 1/*q* = 1/*f*.



A normal eye can focus a sharp image of an object on the retina (at the rear of the eye). Although the mechanisms by which the eye adjusts to produce correctly focused images are complex and intricate, it is possible to understand the principle of image formation using basic math. We utilize a Java applet from the NTNUJAVA Virtual Physics Laboratory website to demonstrate the behavior of light rays passing through a lens. http://www.phy.ntnu.edu.tw/ntnujava/index.php?topic=48

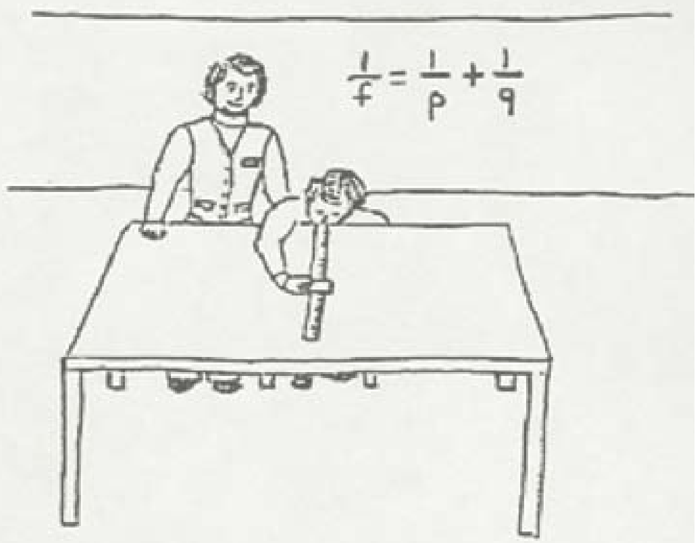
The location of the object and that of the image formed by a lens is governed by the lens equation

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

where p is the object's distance to the lens, q is the image's distance to the lens, and f is the lens's focal length. Evidently we need the skills of manipulating rational expressions and solving rational equations to use this equation.

The eye focuses on an object by varying the shape of the pliable crystalline lens through a process called accommodation. The lens adjustments take place so swiftly that we are not even aware of the change. Accommodation is limited in that objects very close to the eye produce blurred images. The near point is the closest distance for which the lens can accommodate to focus light on the retina. This distance usually increases with age and has an average value of 25 cm. The far point of the eye represents the greatest distance for which the lens of the relaxed eye can focus light on the retina. A person with normal vision can see very distant objects and, therefore, has a far point that can be approximated as infinity.

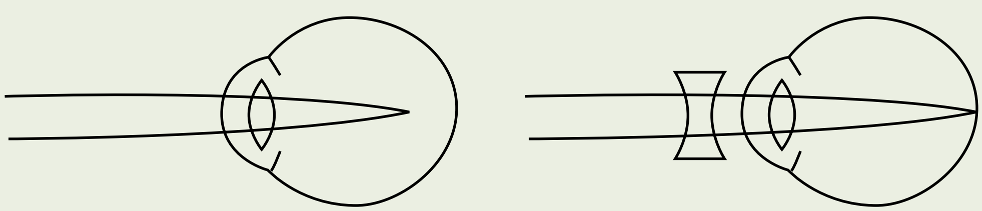
Figure 2: A simple way to find your own near point.



Find out your own near point:
Remove your glasses or contacts if you wear any, close one eye, and then bring this page closer to your open eye until it becomes indistinct. The distance from the page to your eye is the near point.

When the eye suffers a mismatch between the focusing range and ? light rays from an object will not converge to form an image on the retina. Nearsightedness can be corrected with a diverging lens, and farsightedness can be corrected with a converging lens. Optometrists and ophthalmologists usually prescribe lenses measured in diopters: the power $\boldsymbol{P}$ of a lens in diopters equals the inverse of the focal length in meters, $\boldsymbol{P} = 1/\boldsymbol{f}$. For example, a converging lens of focal length +20 cm has a power of +5.0 diopters, and a diverging lens of focal length –40 cm has a power of –2.5 diopters. Let us work out some examples.

Figure 3: The nearsighted eye, and the defect remedied by concave glasses.



Source: http://tinyurl.com/c67dzs

Toxic Bulbs

Frank Wang
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

Students have heard energy experts suggesting that they replace regular incandescent light bulbs with compact fluorescent bulbs to reduce electricity consumption. However, there are no costless solutions to environmental protection, since all measures create their own sets of side effects. This activity is based on a short article in *Scientific American*. It guides students through an analysis of many environmental issues. The math involved includes number sense and rational expressions.

Math Topics
Rational expressions

Purpose
Motivation

Comments
Based on reading a *Scientific American* article.

When to Introduce
Week 7

Duration
One week

Activity Time Frame
Two class sessions are required to complete Part 1 of the activity, with students working in small groups. Two additional weeks will be needed in order to complete subsequent parts of the activity independently and to write a summary reflective essay.

Reflection

This project is straightforward. Even non-math faculty found the issue to be interesting. To many students, this assignment was an eye-opener because they were not aware of the possible side effects of mercury pollution if we do not recycle. Most corporations such as Wal-Mart are slow in implementing recycling programs because they will obviously reduce profits. This assignment gave students the opportunity to examine an issue from different points of view. It also contained a sample calculation, and by doing it in class, students learned the meaning of the technical term kilowatt hour, which many students have seen in their utility bills.

This lesson first appeared on LaGuardia Community College's *An Inconvenient Truth* teaching resources website . After suggestions by my colleagues in the Project Quantum Leap seminar series, I made several revisions. I particularly thank Dr. Judit Török and Dr. Javier Roldan McKinley for reviewing my lesson and solving the problems as if they were students. Their hard work provided me with the most valuable feedback; as a result this lesson became much more comprehensible. Dr. McKinley's admirable solution is included as a resource to help an instructor check students' work. Ros Orgel's critical reading of my text gave me the idea to incorporate a Con Edison bill to help students connect math to their lives. My experience shows how peer critique can strengthen a lesson, in turn enriching student learning.

Activity Overview

Based on feedback from math and non-math faculty, this activity is easy to understand. Depending on available time, this activity can take as few as 15 minutes, or as many as 60 minutes.

The instructor should distribute the handout to students, and spend approximately five minutes discussing how energy production (from coal-fired, natural gas-fired or nuclear power plants) inevitably associates with some environmental impact. Although it is obvious that reducing electricity consumption is a desirable act, the pollution that results from compact fluorescent bulbs serves as an example to illustrate that there are no costless solutions to environmental problems.

Time permitting, the instructor might go over the sample calculation; if not, it is not difficult for students to work out the answer by themselves. Students should be told that they are expected to (i) read the article; (ii) perform calculations and answer the questions; and, (iii) write a reflection. It will be helpful to read the guiding questions (reprinted below) to students.

- What are the environmental challenges that we are facing?
- What are the advantages and disadvantages of replacing regular incandescent light bulbs with compact fluorescent bulbs (CFLs)?
- Describe a CFL recycling program in your area, and make this information known to the readers of your essay.

Materials and Resources

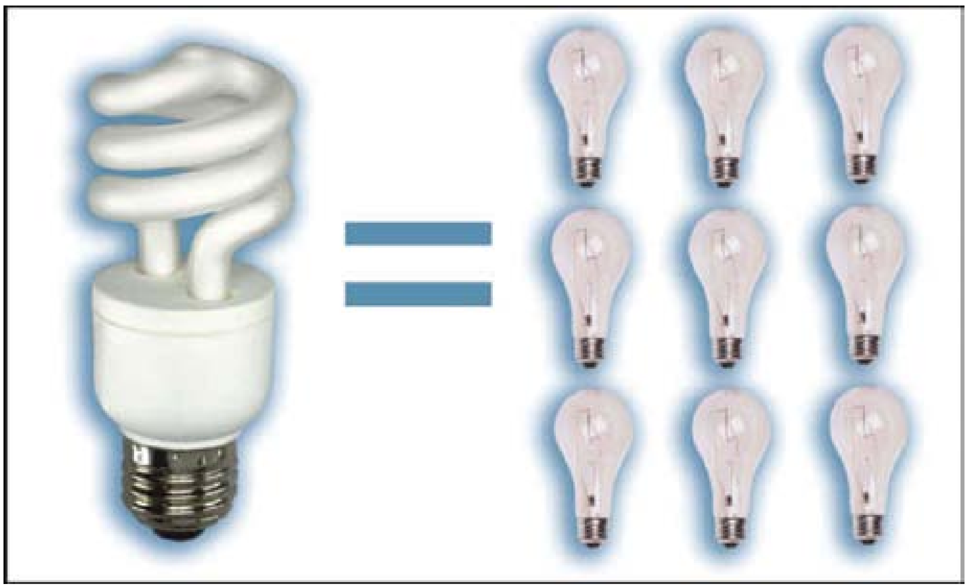
- Handout
- Reading: Appell, D. (October 2007). Toxic bulbs. *Scientific American*. 30–31.
- Example of a ConEdison electricity bill
- For the solution prepared by Dr. Javier Roldan McKinley, please contact Frank Wang at fwang@lagcc.cuny.edu for instructor's version with answers.
- Environmental Protection Agency U.S. Department of Energy Energy Star. (n.d.) *Compact fluorescent light bulbs for consumers*. Retrieved February 4, 2009, from http://www.energystar.gov/index.cfm?c=cfls.pr_cfls
- You can also find a CFL recycling program in your area by visiting www.lamprecycle.org. National Electrical Manufacturers Association. (2003). *Lamp recycling.org*. Retrieved February 4, 2009, from http://www.lamprecycle.org/

Handout: Toxic Bulbs

Wang | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Activity

More consumers are placing compact fluorescent light bulbs (CFLs) in their shopping baskets. Using 25 percent of the energy of standard incandescent light bulbs, and lasting 10 times longer, the swirly little tubes have become a symbol of green living and a means to fight climate change. Yet CFLs have a downside: the bulbs contain mercury and cannot be tossed out with ordinary trash.



Source: http://dannyseo.typepad.com/photos/uncategorized/2007/06/10/cfl.jpg

SENCER Approach

You will put your scientific knowledge and mathematical skills to immediate use in understanding CFL-related environmental issues. After you read the assigned article, you will answer questions and perform mathematical calculations involving:

a. percentages

b. number sense

c. equations

d. linear functions

Reading: Toxic Bulbs

Wang Elementary Algebra – Problems and Issues in Public Health (MAT096)

Source: Appell, D. (October 2007). Toxic bulbs. *Scientific American*. 30–31.

ENVIRONMENT

Toxic Bulbs

Recycling rules vary for mercury-containing fluorescents BY DAVID APPELL

More consumers are placing compact fluorescent lightbulbs (CFLs) in their shopping baskets. Using 25 percent the energy of standard incandescents (and lasting 10 times longer), the swirly little tubes have become a symbol of green living and a means to fight climate change. Australia will require homeowners and businesses to replace all incandescents with CFLs by 2010, ultimately reducing greenhouse gas emissions by four million metric tons a year. At least four U.S. states and Congress are considering similar legislation.

Yet CFLs have a downside: the bulbs contain mercury and cannot be tossed out with the ordinary trash. Roughly two billion will be sold in the U.S. this year (about 5 percent of the total lightbulb sales)—raising questions of how to handle 10 metric tons of mercury each year after the bulbs burn out.

Mercury is essential to the function of fluorescent bulbs. An electrostatic charge vaporizes the mercury and induces it to emit ultraviolet light, which makes the phosphorous coating inside the bulbs glow. A potent neurotoxin, mercury is especially dangerous for fetuses and children. In the U.S. today about one sixth of children are born having been exposed to mercury levels so high they are at risk for memory loss and learning disabilities, according to the Environmental Protection Agency.

Each CFL contains about five milligrams of mercury, about equal to the amount of ink on the tip of a ballpoint pen. Of course, mercury in a CFL does not pose the same kind of risk as, for instance, mercury in fish (the U.S. Food and Drug Administration sets a limit of 0.17 milligram in a six-ounce can of tuna). But it can leach out of landfills into water supplies or become airborne if incinerated.

Despite years of effort, manufacturers have failed to find a replacement for mercury, although they have succeeded in reducing the amount of mercury per bulb. "Manufacturers have grown more obvious in their attention to the mercury content of lamps," says Bill Stanwood of the Product Stewardship Institute, a Boston-based nonprofit that seeks to reduce the health and environmental impact from consumer goods. Whereas industrial users are familiar with the need to recycle linear tubes, residential consumers have yet to catch on—the recycling rate for fluorescent bulbs in the U.S. is about 24 percent, according to the Association of Lighting and Mercury Recyclers. "About one third of the country lives where you can't throw this stuff into the garbage legally," says the association's Paul Abernathy.

Currently CFL recycling options vary across the country. Sylvania offers a mail-back recycling kit that costs about $1 a bulb. Wal-Mart, which last year announced a goal of selling 100 million CFLs annually, now has kiosks for spent CFLs, but only in its California stores. The U.S. Postal Service is considering a recovery program with recycling containers at their stations.

At least one state is showing that CFL recycling is economically feasible. Vermont has one of the highest levels of CFL sales per household, and in 1998 it was the second state (after Minnesota) to pass a law requiring the recycling of CFLs. In August 2005 True Value hardware stores in Vermont began taking back customer's spent bulbs and shipping them back to warehouses on merchandise-delivering trucks. This "reverse distribution" process costs about 35 cents per bulb, says Karen Knaebel, Mercury Education and Reduction Coordinator for Vermont's Department of Environmental Conserv tion. (A state survey found that two thirc of Vermonters would pay 50 cents to r cycle a bulb.)

FIXTURE IN A GREEN HOME: Compact fluorescent bulbs use less energy than standard incandescent bulbs, but because they contain mercury, they pose an environmental risk of their own.

With this strategy, Vermont has rec cled 13,000 linear feet of traditional flu rescent lighting and 4,000 CFLs in almo two years. The recycling rate is current increasing at 17 percent a year.

Stanwood's organization hopes t translate that kind of success to the rest the country. His group is working on plan to facilitate a national dialogu among interested parties to establish mo standardized procedures for CFL rec cling. But until they are set, consume who want to recycle will have to fend f themselves once the lights go out.

And If You Break a CFL ...

Although compact fluorescent lightbulbs contain mercury, breaking one in your home will not require a costly visit by a hazmat team. Open windows to dissipate mercury vapor. Then, while wearing gloves, use sticky tape to pick up the small pieces and powdery residue from the bulb's interior. Place the tape and large pieces of the bulb in a plastic bag. After vacuuming the area, place the vacuum bag inside doubly sealed plastic bags before discarding.

Check the Environmental Protection Agency's Energy Star Web site, www.energystar.gov/index.cfm?c=cfls.pr_cfls, for more information.

To find a CFL recycling program in your area, go to www.lamprecycle.org

Sample Problem

Energy experts tell us to replace regular incandescent light bulbs with compact fluorescent bulbs, but it seems hard to justify spending $15 on a light bulb. A 60 W incandescent bulb costs 50 cents and has a lifetime of 1000 hours. A 15 W compact fluorescent bulb produces the same amount of light as a 60 W incandescent bulb and is intended as a replacement. It costs $15 and has a lifetime of 10,000 hours. Compare the life-cycle costs of 60 W incandescent bulbs to 15 W compact fluorescent bulbs. Which is the cheaper source of light? Assume that electricity costs $0.10/kWh.

Answer

Before solving this problem, let's understand what $0.10/kWh in the last sentence means. Examine a Con Edison bill (see sample below). Did you find a line that reads "Total KWH used in 30 days?" The unit KWH is an abbreviation of the term "kilowatt-hour," a unit that measures energy consumption. Below that line, you should find charges for electricity used, and "COST/KWH" (cost per kilowatt-hour). The cost rate typically varies and is not our main concern. The bottom line is that electricity usage is measured in kilowatt-hours, and in this example we assume that each kilowatt-hour costs 10 cents, which is fixed.

Fluorescent bulb

Cost of bulb: 15.00

Cost of electricity for 10,000 hours:

$$15 \times 10{,}000 = \frac{0.1}{1{,}000} = 15.00$$

Total cost: 15.00 + 15.00 = 30.00 dollars

Incandescent bulb

Number of bulbs needed for 10,000 hours: 10,000/1000 = 10

Cost of bulbs: $10 \times 0.50 = 5.00$.

Cost of electricity:

$$60 \times 10{,}000 = \frac{0.1}{1{,}000} = 60.00$$

Total cost: 60.00 + 5.00 = 65.00 dollars

Conclusion

Although an incandescent bulb is much cheaper, in the long run (10,000 hours), the fluorescent bulb will cost $30.00, while the incandescent bulb will cost $65.00.

conEdison www.coned.com

Amount now due
$62.36
Payment due upon receipt of this bill

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BROOKLYN NY 11231-4404

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NY NY 10116-1702

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17 19

Detach here when paying by mail - bring entire bill when paying in person.

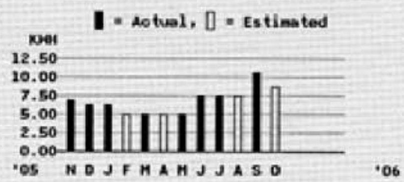
Your account number	Next reading date	For service and billing information call
66-6666-6666-0000-0	NOV 20, 2006	1-212-243-1900 OR 1-800-752-6633

17 Service to: JOE NEW BILL
at: 123 TEST STREET 1B

ELECTRIC USE - RATE EL1 RESIDENTIAL

10/20/06 reading (Estimated)....	728
09/20/06 reading (Actual).......	-458
Total KWH used in 30 days......	270

AVERAGE DAILY ELECTRIC USE



CHARGES FOR ELECTRICITY USED

Basic service charge: (does not include usage)			$11.31
	KWH	COST/KWH	
First	250.0 @	19.2440¢	48.11
Next	20.0 @	18.8500¢	3.77
Adjust. Factor	@	-1.1963¢	3.23CR
Sales tax @		4.0000%	2.40

BILLING SUMMARY AS OF 10/23/06

Amount due last bill...	$138.12
Payments through 10/19	$138.12CR
Balance remaining......	NONE
CURRENT ELEC CHARGES...	$62.36
TOTAL AMOUNT NOW DUE...	$62.36

CURRENT ELECTRIC CHARGES $62.36

This bill includes an electric supply cost of 10.6¢ per KWHR.
Go to a new supplier to reduce charges by 1.5¢ per 10 KWHRS and lower taxes.

IMPORTANT MESSAGES

Your bill includes a charge of $0.63 to fund NYS renewable energy, environmental, and other energy-related public policy programs.

To avoid a 1.5% monthly late payment charge, pay the Total Amount Due of $62.36 by NOV 14, 2006.

A 7% Discount For You.
Receive a 7% discount off the Con Edison price for energy supply for 2 months when you purchase energy from an energy services company(ESCO) with PowerMove. To enroll with a participating ESCO, call 1-877-MOVE-234 (1-877-668-3234) or go to www.poweryourway.com today.

YOUR DOLLAR FOR ENERGYSHARE CAN MAKE A DIFFERENCE
If you pay the total amount of this bill and exactly $1.00 more, that dollar will go into the EnergyShare fund sponsored by Con Edison. And, Con Edison matches each contribution. EnergyShare helps eligible residential customers who are struggling to pay their bills with one-time grants of up to $200.

conEdison Keep this part for your records. See reverse side for additional information. www.coned.com

Questions

1. Roughly two billion CFLs will be sold in the U.S. this year, representing 5 percent of total light bulb sales. What is the total amount of total light bulb sales in the United States?
2. In the U.S. about one sixth of children are born having been exposed to mercury levels so high that they are at risk for memory loss and learning disability. Let us suppose that there are 84 million children in the U.S. How many children are at risk?
3. According to the article, each CFL contains about five milligrams of mercury. Wal-Mart announced a goal of selling 100 million CFLs annually. How many grams of mercury are contained in 100 million CFLs?
4. The recycling rate for fluorescent bulbs in the U.S. is about 24 percent. Let us assume a recycling rate of 25 percent for the Wal-Mart CFLs. How many grams of mercury is not recycled?
5. What do you do if you accidentally break a CFL?

Reflection

There is no costless solution to environmental protection, and all measures create their own sets of issues. After performing the above calculations, write an essay to reflect your learning. Quantitative reasoning is generally the strongest support for an argument. Therefore, when writing your essay, you need to incorporate the mathematical work that you have performed. The following guiding questions will help you organize your essay.

1. What are the environmental challenges that we are facing?
2. What are the advantages and disadvantages of replacing regular incandescent light bulbs with compact fluorescent bulbs?
3. Describe a CFL recycling program in your area, and make this information known to the readers of your essay.

You might visit the website of the Environmental Protection Agency at http://www.energystar.gov/index.cfm?c=cfls.pr_cfls .

You can also find a CFL recycling program in your area by visiting www.lamprecycle.org.

What Happened to the AIDS Epidemic?

Frank Wang
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

Students will put their scientific knowledge and mathematical skills to immediate use in understanding HIV/AIDS-related health issues. After they read an assigned article from *Science,* they will be asked to answer questions and perform mathematical calculations involving (1) percentages, (2) number sense, (3) equations, (4) linear functions, and (5) quadratic function.

Math Topics
Linear equations, rational expressions, quadratic formula

Purpose
Synthesis

Comments
Based on a *Science* magazine article

When to Introduce
Week 5

Activity Time Frame
Five weeks

Reflection

Since the AIDS epidemic was officially recognized in 1981, it has killed more than half a million Americans, a total exceeding all American combat-related deaths in all wars fought in the 20th century. Over the last decade, annual AIDS cases and deaths have fallen dramatically due to great advances in treatment and prevention education. As a result, the general public appears to find the AIDS epidemic less alarming. However, there are still reasons for concern. Is the AIDS crisis over? How do governmental policies impact the AIDS epidemic? What community leadership is needed for HIV/AIDS prevention?

In this activity, I tried to design problems that require the integration of various mathematical skills to address HIV/AIDS-related health issues. Students need to understand the language and factual information in the problem, translate the problem using relevant information to create an adequate mental representation, devise and monitor a solution plan, and execute adequate procedural calculations. Students were asked to write an essay, supported by the data and mathematical models.

After I implemented this activity, most students were conscious of incorporating numerical information in their "AIDS Epidemic" essays. The positive aspect is that students were compelled to incorporate math into their writing, and they got a flavor of technical communication among professionals. However, insertion of data and math reasoning were rather unnatural; most students merely paraphrased statements in the assigned reading or other sources, combining them with personal impressions. Nevertheless, I believe that the outcome of this project was positive. I suspect that students do not often get to practice technical writing. Even though students did not produce papers of consistently satisfactory quality, I believe they should be commended for their efforts.

Activity Overview

This activity should be introduced in the fifth week of the semester; the activity spreads over five weeks.

Fifth week (15 minutes in class): Distribute the handout and reading. Briefly describe to students the issues related to HIV/AIDS, particularly the statistical trend, and ask students to read the article at home.

Sixth week (15 minutes in class): Give students the opportunity to ask questions arising from reading the article, and ask them to attempt Problems 1–6 in the handout.

Seventh week (45 minutes in class): Check students' work on Problems 1–6, and give students hints on Problems 7–8.

Eighth week (45 minutes in class): Go over Problems 7 and 8, which illustrate the concepts of linear and quadratic equations.

Ninth week (30 minutes in class): Wrap up the activity with a class discussion or additional review, and ask students to write a reflection.

Materials and Resources

1. Handout (Please contact Frank Wang at fwang@lagcc.cuny.edu for instructor's version with answers)
2. Reading: Jaffe, H. (2004, August 27).Whatever happened to the U.S. AIDS epidemic? *Science*, 305, 1243–1244.
3. Centers for Disease Control and Prevention. (2009, January 14). *Basic Statistics.* Retrieved February 4, 2009, from http://www.cdc.gov/hiv/topics/surveillance/basic.htm
4. McNeil, D. (2007, March 31). Audit finds Bush's AIDS effort limited by restrictions. *New York Times*, A12.

Handout: What Happened to the AIDS Epidemic?

Wang Elementary Algebra – Problems and Issues in Public Health (MAT096)

Introduction

Since the AIDS epidemic was officially recognized in 1981,[1] it has killed more than half a million Americans, a total exceeding all American combat-related deaths in all wars fought in the 20th century. Over the last decade, annual AIDS cases and deaths have fallen dramatically due to great advances in treatment and prevention education. As a result, the general public appears to find the AIDS epidemic less alarming. However, there are still reasons for concern.

SENCER Approach

You will put your scientific knowledge and mathematical skills to immediate use in understanding HIV/AIDS-related health issues. After you read an assigned article, you will answer questions and perform mathematical calculations involving:

- percentages
- number sense
- solving equations
- linear functions
- quadratic functions

Is the AIDS crisis over? How do governmental policies impact the AIDS epidemic? What community leadership is needed for HIV/AIDS prevention? You should be able to address these issues after this exercise.

You will write an essay to reflect your learning. You need to incorporate the data and mathematical models into your paper. Specifically, you will discuss the projections suggested by the mathematical models and graphs.

Reading Assignment

Jaffe, H. (2004, August 27).Whatever happened to the U.S. AIDS epidemic? *Science,* 305, 1243–1244.

Questions

1. The article cites a Kaiser Family Foundation survey of Americans' opinions on the world's health problems. Based on the survey, what are the two most urgent health problems facing the world today?

2. Let us assume that a telephone survey was conducted, interviewing 2500 people in the United States.[2]

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[1] On June 5, 1981, the Centers for Disease Control and Prevention issued its first warning about a disease that would become known as AIDS.

[2] The actual Kaiser Family Foundation survey included an oversample of African-American and Latino respondents, then weighted results for all groups to reflect their actual distribution in the nation. Here we use a simplified model for students.

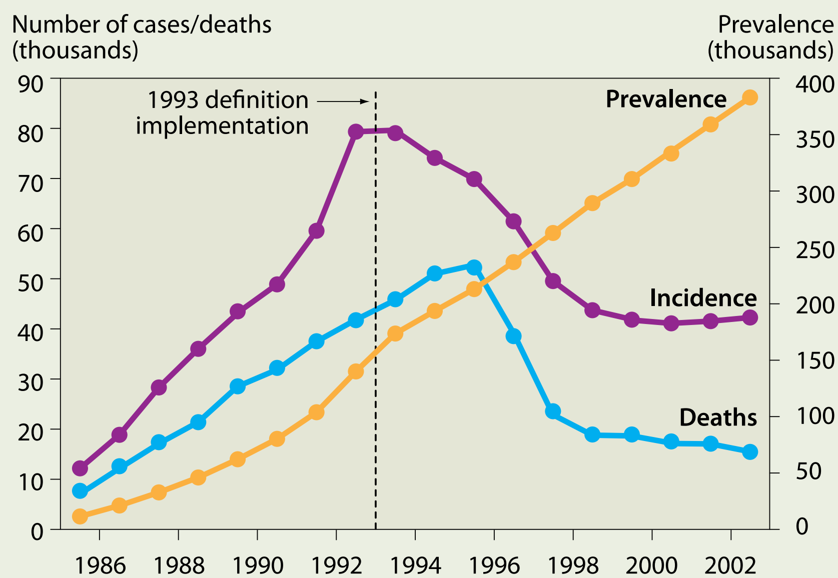
a. If the conclusion is that 36% of Americans believe that AIDS is the most urgent health problem, how many respondents among the 2500 surveyed provided that response?
b. If 1,025 out of 2,500 respondents answered that cancer was the most urgent health problem, what is the percentage of Americans who provided that response?

3. The 2005 federal budget for domestic and global HIV/AIDS funding is $19.8 billion, a 7% increase over the 2004 fiscal year. What is the budget for the 2004 fiscal year?

4. What is the most important demographic (racial background and economic status) shift of persons with AIDS stated in the article?

This figure shows the number of new AIDS cases, deaths, and persons living with AIDS in the United States.

The number of new AIDS cases, deaths, and persons living with AIDS in the United States.



Source: http://www.sciencemag.org/cgi/content/full/305/5688/1243

Stop to think: What are the reasons that the number of Americans living with AIDS continue to rise? What if the incidence curve lies beneath the deaths curve (namely the number of annual deaths is greater than the number of newly infected cases)?

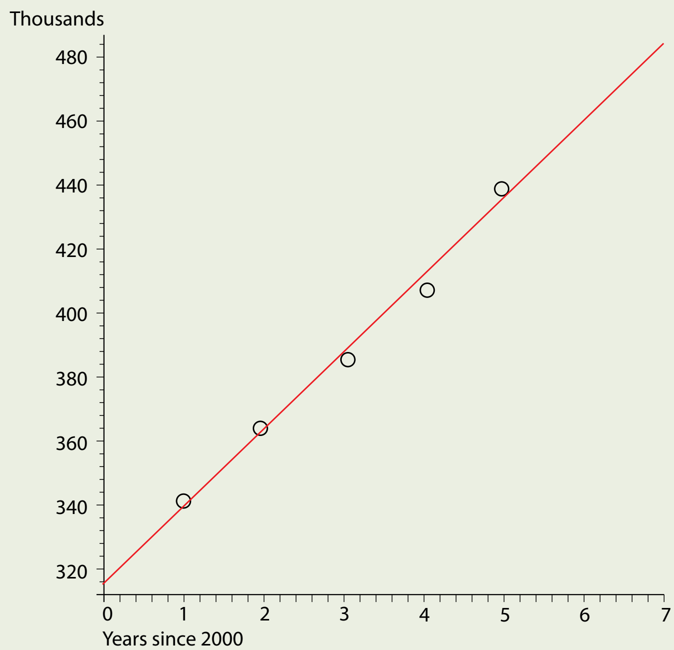
5. The number of Americans living with AIDS continues to rise. From the figure, what is the approximate AIDS prevalence as of 2002?

6. Approximately how many Americans became HIV infected in 2002?

Year	2001	2002	2003	2004	2005
Prevalence (thousands)	341	364	387	409	438

The updated number of Americans living with AIDS is extracted from the CDC database and shown below. Based on the graph, the increase is best modeled by a linear function.

The number of new AIDS cases, deaths, and persons living with AIDS in the United States.



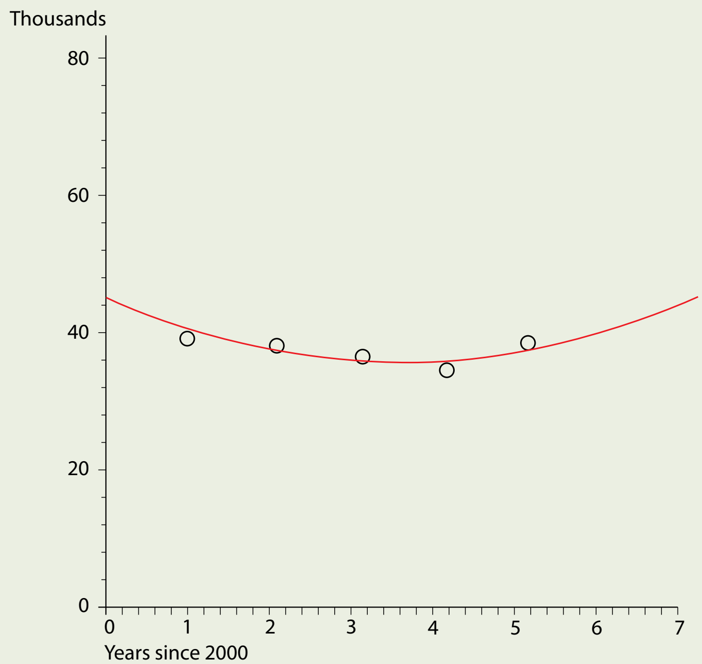
Using computer software such as MAPLE, Excel, or a TI-83 calculator, we obtain a best-fit linear function $y = 23.9t + 316.1$ where y is the number of persons with AIDS in thousands and t is years since 2000.

7. Based on the best-fit linear model, answer the following questions.
   a. What is the projection of prevalence for 2007?
   b. In what year will the prevalence reach 500,000?

The CDC estimates that about 40,000 Americans become HIV-infected each year. The data over the past five years is extracted from the CDC database and shown below. We observe that after years of declining, the number of new cases increased in 2005. We use a quadratic function to model such a trend.

Year	2001	2002	2003	2004	2005
Number of new cases (thousands)	40	38	36	35	38

The number of new AIDS cases, deaths, and persons living with AIDS in the United States.

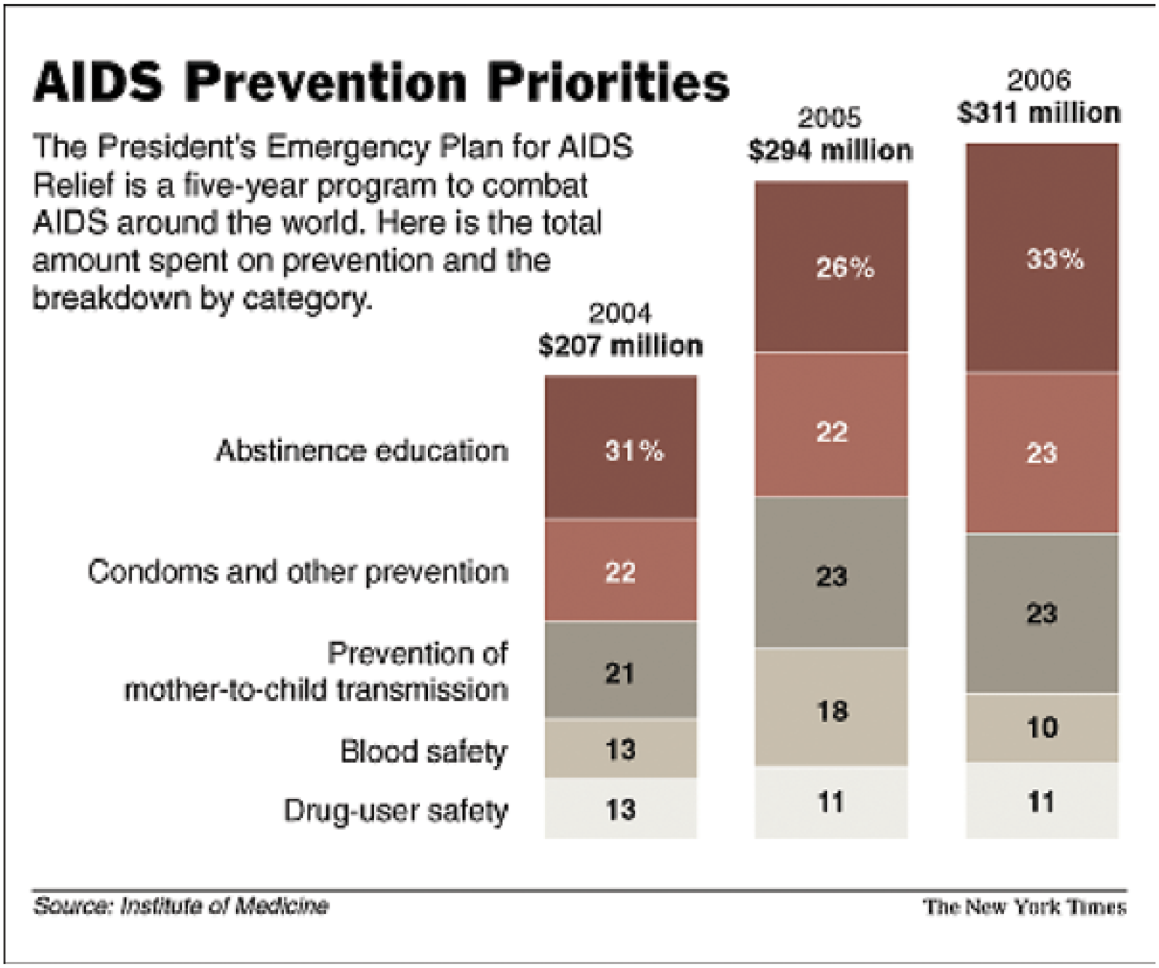


Again using computer software such as MAPLE, Excel, or a TI-83 calculator, the best-fit model is $z = 0.786t^2 - 5.41t + 50.0$ where z is the number of new cases per year and t is years since 2000.

8. Based on the best-fit quadratic model, answer the following questions.
   a. What are the projections of infection for 2006 and 2007?

   b. If we allow the trend based on the quadratic model to continue, when will AIDS incidents reach the 1993 height of 80,000 cases?

9. Sharing of needles and syringes is the main route of HIV transmission among injection drug users. What is the approximate percentage of newly-diagnosed persons with AIDS infected this way?



The chart above is taken from an article "Audit Finds Bush's AIDS Effort Limited by Restrictions" in the *New York Times,* March 31, 2007, A12.

10. Congresswoman A believes that abstinence education is ineffective and that the current administration overemphasizes this single-minded approach. Congressman B is an ardent supporter of the current administration and defends the President's every policy. From the chart, Congressman B told Congresswoman A that the President has indeed decreased abstinence education funding from 31% in 2004 to 26% in 2005. Congresswoman A refuted such a claim and advised Congressman B to review basic math. Who is right? Explain.

ePortfolio Reflection

Write a 2-page essay to reflect your learning after this activity. Think carefully about where the discussion of the mathematical work will be placed in your essay. Some of the questions below might help you to build your essay.

1. When you hear someone saying that the AIDS epidemic is over, how would you respond based on your calculations?

2. Based on the quadratic model, how long will it take for newly HIV-infected cases to reach the highest number since the early 1990s?

3. Overall, AIDS case rates are 10 times higher for African Americans than for white Americans. What are the reasons?

4. What is the impact of AIDS on African-American women and youth?

5. The article concludes that more community leadership is needed for HIV prevention. What can you contribute as a citizen in your community?

6. Does the government hamper efforts to slow the spread of the AIDS epidemic by imposing programs based on ideological, not health concerns?

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- McNeil, D. (2007, March 31). Audit finds Bush's AIDS effort limited by restrictions. *New York Times*, A12 .

Reading: What Happened to the AIDS Epidemic?

Wang Elementary Algebra – Problems and Issues in Public Health (MAT096)

Source: Jaffe, H. (2004, August 27).Whatever happened to the U.S. AIDS epidemic? *Science*, 305, 1243–1244.

POLICY FORUM

PUBLIC HEALTH

Whatever Happened to the U.S. AIDS Epidemic?

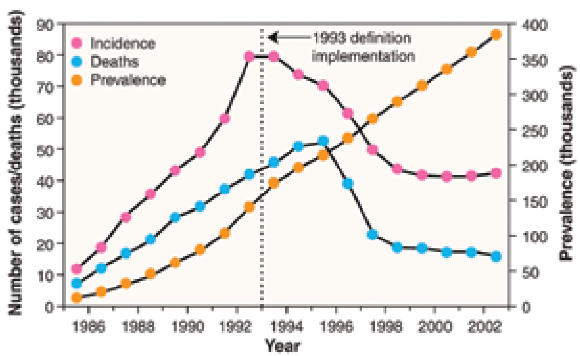
Harold Jaffe

Although more than one-third (36%) of Americans believe AIDS is the "most urgent health problem facing the world today," ranking second behind cancer (41%) (*1*), concern about HIV/AIDS in the United States has been falling. In national surveys, the proportion of Americans who consider HIV/AIDS to be the "most urgent health problem facing this nation today" has decreased from 38% in 1997 to 17% in 2002" (*2*). The Centers for Disease Control and Prevention's (CDC) budget for domestic HIV/AIDS programs increased by only 5% from 2001 to 2004, less than the rate of inflation (*3*).

Some of the decreasing interest in the domestic epidemic is understandable. With the increasing availability of highly active antiretroviral therapy (HAART), annual AIDS cases and deaths have fallen dramatically (see the figure). AIDS is now viewed by many as a chronic disease for which survival can be measured in years rather than months. As the profile of persons with AIDS has gradually shifted from white middle-class gay men to poor African-American and Hispanic residents of the inner city and rural South, and as AIDS "celebrity deaths" become fewer, the general public appears to find the epidemic less alarming. Yet there are still reasons for concern.

The Problem

Since the epidemic was recognized in 1981, it has killed more than half a million Americans, a total exceeding all American combat-related deaths in all wars fought in the 20th century. Despite great advances in treatment, HIV/AIDS is the second leading cause of death in African Americans between the ages of 25 and 44 years. The number of Americans living with AIDS also continues to rise and is now approaching 400,000 (see the figure). Because of variability in state reporting laws and the difficulty in distinguishing between recent and long-standing infection, precise national HIV incidence data are not available. However, the CDC estimates that about 40,000 Americans become infected each year (*4*). This figure is not believed to have changed over the last decade. The mean annual expenditure for care of an HIV-infected patient in the HAART era is estimated to be about $18,000 (*5*).



Number of AIDS cases, deaths, and persons living with AIDS in the United States. Numbers are adjusted for reporting delays. All surveillance data are from (*23*).

A major challenge to prevention is to increase the number of persons who know their HIV infection status. Without this knowledge, infected persons cannot know they may be transmitting the virus to others and will not receive HIV treatment and care. Yet of the estimated 850,000 to 950,000 infected Americans, about a quarter are unaware of their infection (*6*). Even when persons do seek testing, it is often late in the course of their infection. For example, during 2000 and 2001, 37% of persons diagnosed with HIV either had AIDS at the time of their first positive test or developed an AIDS-defining condition within a year of that test (*7*). To some extent, this problem reflects the reluctance of health care providers to offer routine testing to persons at risk for HIV infection or living in high-prevalence areas. Early in the epidemic, there was strong opposition to HIV testing because of perceptions that the test was inaccurate and the confidentiality of results could not be maintained (*8*). Many providers also considered the requirements for extensive pretest counseling burdensome. Moreover, because treatment was not available, there was little incentive to learn one's infection status.

Although the proportion of men who have sex with men (MSM) among reported AIDS cases has decreased, this population still accounts for the largest number of persons with AIDS. Further, in the 30 states with long-standing reporting of HIV infection, diagnoses among MSM increased 17% from 1999 to 2002, while remaining stable in other risk groups. Outbreaks of infectious syphilis in MSM, about half of whom are HIV-infected, indicate ongoing high-risk behavior. The continuing HIV epidemic in MSM remains a prevention challenge, with no easy answers. Many factors may be contributing to these behaviors (*9*). One likely explanation is that HIV/AIDS is no longer viewed as a fatal disease. Older MSM may also be suffering from "prevention fatigue," meaning that they are simply tired of hearing the same prevention messages. For younger MSM, the lack of apparent illness in peers along with the belief that HIV/AIDS was only a problem for a past generation may contribute to risk-taking behavior. Other factors contributing to unsafe sex may include the use of recreational drugs, particularly crystal methamphetamine (*10*) and easy access to anonymous partners through the Internet (*11*).

Among African Americans, the epidemic poses particular prevention challenges. Overall, AIDS case rates are 10 times higher in African Americans than in white Americans. Reasons cited for these high rates include poverty, substance abuse, increased rates of other sexually transmitted diseases that facilitate HIV transmission, and lack of access to and utilization of health care. Particularly hard hit have been African-American women and youth, who account for about two-thirds of AIDS cas-

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www.sciencemag.org SCIENCE VOL 305 27 AUGUST 2004 *Published by AAAS*

es in women and teenagers, respectively. Many of the young women are being infected by older male sex partners. Bisexual men may also be playing a role in transmission to women. In one study of HIV-infected MSM, 34% of African Americans acknowledged having sex with both men and women as compared with 13% of non-Hispanic whites (*12*) .

Some Solutions

To address some of the prevention challenges, CDC announced a new public health initiative in 2003: *Advancing HIV Prevention: New Strategies for a Changing Epidemic* (*4*). Much of the initiative is focused on increasing knowledge of infection status by making HIV testing a routine part of medical care and providing new models of testing outside of medical settings. The initiative also emphasizes prevention programs for infected persons, including strategies to decrease mother-to-child HIV transmission. In the prenatal setting, for example, voluntary "opt-out" testing (notification that an HIV test will be included in a standard battery of prenatal tests unless refused) is now a recommended approach to prevent perinatal transmission (*13*). Pretest counseling need not be extensive (*14*).

A key technical advance for increasing knowledge of infection status has been Food and Drug Administration (FDA) approval of a rapid HIV antibody test that can be performed outside the laboratory and provide results in about 20 minutes (*15*). The use of this test is now being evaluated for persons receiving care in medical settings, such as emergency departments, as well as in nonclinical settings, such as mobile outreach vans. Persons with negative results can be told they are not infected. Those with positive results are told that they are likely infected and are asked to return in a week or two for a confirmed result.

Progress in HIV prevention will also require identifying new prevention venues, such as correctional facilities. At any given time, about 2 million Americans are incarcerated in prisons or jails. At the end of 2001, 2.0% of state prison inmates and 1.2% of federal prison inmates were known to be HIV infected (*16*). Many other jail and prison inmates are at risk for infection upon release based on their histories of drug use or high-risk sex. In jails, where stays are typically only a few days, rapid HIV testing is feasible and can be linked to prevention and care services for those found infected. In prisons, where stays are longer, more comprehensive HIV prevention programs can be instituted. Making HIV prevention a priority in correctional settings will require both funding and a commitment from public health and correctional officials.

Advancing beyond the status quo may also require actions that have not been politically acceptable. For example, sharing of needles and syringes is the main route of HIV transmission among injection drug users, who still account for almost a quarter of newly reported persons with AIDS. However, access to sterile injection equipment is often limited by state laws that restrict sales of syringes, criminalize their possession, and limit the operations of needle and syringe exchange programs. Although exchange programs have been shown to reduce needle sharing (*17*) and are supported locally by city governments and community-based organizations, as well as internationally by the governments of many other industrialized countries, the use of U.S. government funds for these programs is prohibited. HIV prevention programs for injection drugs users should also include access to high-quality addiction treatment, along with prevention case management services for infected persons; such services are not always available or adequately funded.

The role of abstinence programs has also been politicized in the development of HIV prevention strategies. Abstinence, including interventions to delay the onset of sexual activity, clearly makes sense as a prevention strategy for youth, and has been shown to be effective in heavily affected countries, such as Uganda (*18*). However, the majority of American teenagers, over 60% in 2003, report that they have been sexually active by the time they are high school seniors (*19*). Additionally, the "abstinence until marriage" message has no meaning for gay and lesbian persons, for whom marriage is illegal in most of the United States. In contrast, prevention strategies emphasizing correct and consistent use of male condoms, a highly effective means to prevent HIV transmission (*20*), have been criticized (*21*).

New voices and community leadership to support HIV prevention are urgently needed. The dramatic upswing of HIV infections that occurred among MSM during the early 1980s was followed by an equally dramatic drop in incidence during the mid-to-late 1980s (*22*). This reduction occurred well before substantial federal or local funding for HIV prevention became available and almost certainly reflects prevention efforts within gay communities themselves. However, many of the leaders of those efforts have either died or are no longer active in HIV prevention. Although current activism largely has focused on access to therapy, more advocacy for prevention is critical. The message must be that prevention of HIV infection is of paramount importance, even though the infection is now treatable. Infected persons, individuals who know the burden of lifelong treatment with potentially toxic drugs, could be particularly credible spokespersons.

Similarly, more HIV prevention leadership is needed in the African-American community. Because of a variety of issues, particularly those related to racism, stigmatization, and homophobia, there has been some reluctance within this community to acknowledge the seriousness of the HIV/AIDS problem. For some, the epidemic may be just one more burden to bear. The black church and other faith-based entities, powerful social forces in the African-American community, can play critical roles in HIV prevention. Without political, community, and faith-based leadership, the problem will only become worse.

Americans should be proud that their country is now fully engaged in the global fight against HIV/AIDS. At the same time, however, we must ask ourselves why we, collectively, don't care more about the domestic epidemic. Thousands of young Americans are dying each year of a preventable infection.

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24. I thank M. Chamberland, T. Durham, S. Jones, G. Millett, R. Moseley, and R. Valdiserri for their helpful comments.

Pollen Count Levels and Allergies

Mangala Kothari
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

This lesson will demonstrate to students the connection between mathematical concepts and the real world. The activity will enhance students' understanding of pollen counts and the related health problem of allergies, while providing a context through which to review linear, quadratic and graphing functions, as well as the applications of these functions. At the end of the project, students will have acquired the skills to develop mathematical models and use them to make predictions.

Math Topics
Linear and quadratic equations

Purpose
Review

When to Introduce
Week 3 and week 6

Activity Time Frame
One-hour class time and one week to complete each handout

Reflection

This activity is based on information adapted from the Asthma and Allergy Foundation of America website (http://www.aafa.org), a reputable source. Today, millions of Americans suffer from seasonal allergies. This health problem is often overlooked, and sometimes may lead to other medical conditions. The activities allow students to apply linear and quadratic functions from the syllabus to connect two topics: pollen counts and health issues such as allergies and asthma.

The project is composed of two activities, each of which is based on the same reading material. Activity 1, covered in Handout #1, is based on linear functions. It involves understanding simple concepts such as slope and the equation of a straight line, and finding the values of a given function. This activity is introduced during the third week, when students have been taught slope and techniques of finding linear equations. It allows students to review the material and gauge their graphing skills and ability to find the value of a function from its graph.

In Activity 2, covered in Handout #2, quadratic functions are discussed. The activity involves understanding concepts such as graphs of nonlinear functions, interpretation of data, and using quadratic functions to find specific values. This activity is introduced during the sixth week. By comparing different mathematical models, students can clearly see that neither model is perfect, that neither can be used for predicting pollen counts throughout the year. Thus, they realize the limitations of mathematical models. The graphing of equations using Excel also gives students hands-on experience with computer software technology.

Activity Overview

Handout #1:

The project should be introduced after reviewing the following material: ordered pairs, plotting points in the coordinate plane, and graphing straight lines. The concept of dependent and independent variables can also be reviewed. The instructor can review the method of finding the equation of a line that passes through two points. Students are asked to find the equation of the regression line that represents the given data.

Step 1: Students are given handouts detailing the activity/project and are asked to read material on "Pollen and Mold Counts" available at http://www.aafa.org/display.cfm?id=9&sub=19&cont=264.

Step 2: During the second meeting, there is a brief discussion of the reading material and an overview of the assignment. The instructor reviews the concept of slope, finding the equation of a line, and using the equation to find more points on the line. The instructor can also show students how to graph curves of best fit using Excel.

Step 3: Students should be given about one week to complete their assignment. The instructor should allow time for small group discussion in class to help students with the assignment and review their progress on the project.

S***tep 4:*** After assessing the project, the instructor should provide feedback on common errors and clarify the concept of mathematical models. The instructor should check for mathematical as well as conceptual understanding errors.

Handout #2:
Step 1: The instructor recapitulates the main points of the reading material, initiating the discussion by asking students the following question: "Since the straight line equation does not work to predict the exact pollen levels for all times of the year, is there any other type of model that would work better?"

Step 2: The instructor provides an overview of the assignment. He/she can go over the method of plotting points and graphing curves, such as parabolas. Students can hand-draw the graph and use the equation provided by the instructor to answer questions in the assignment. If possible, the instructor should show students how to graph curves of best fit in Excel.

Step 3: Students should be given about one week to complete their assignment. The instructor should allow time for short class discussions (about 15 minutes) to encourage collaboration among students and to assess their progress on the project.

Materials and Resources:

- Handout #1: Linear Equations
- Handout #2: Quadratic Equations
- Pollen.com. *30 Day historic allergy and pollen levels*. Retrieved October 4, 2010, from http://www.pollen.com/historic-pollen-levels.asp
- Reading: Allergy and Asthma Foundation of America. *Pollen and mold counts*. Retrieved October 4, 2010, from http://www.aafa.org/display.cfm?id=9&sub=19&cont=264
- New York City Department of Health and Mental Hygiene Childhood Asthma Inititiative. (2003, May). *Asthma Facts*. P. 18. Retrieved November 4, 2010 from http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf

Handout#1: Linear Equations

Kothari | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Introduction

Straight lines are represented by linear equations, which are of the type $ax + by = c$ or $y = mx + b$. From statistical data given in the form of a chart, one can write the set of ordered pairs and plot them to create a graph. This graph of points is called a scatter plot. The curve of best fit can be obtained by connecting a maximum number of the points. Using algebraic techniques or graphing utilities, mathematicians can find the equations that represent best fit curves and use them to study the behavior of the data. One can also make predictions based on these graphs to determine additional data points that were not given in the original data. This analysis helps in understanding and interpreting the relationship between two physical quantities, namely x and y variables. Reading #1 will help you gain an understanding of pollen count and its importance to people who have pollen allergies.

Based on the reading, answer the questions below. Here is some additional information that may help you respond to these questions.

Pollen Level: The pollen forecast is usually given as low, moderate, high, or very high. Many factors such as weather, location, time, etc. affect the calculation of the pollen index.

Low:	Pollen levels between 0 and 2.4
Low Medium:	Pollen levels between 2.5 and 4.8
Medium:	Pollen levels between 4.9 and 7.2
Med-High:	Pollen levels between 7.3 and 9.6
High:	Pollen levels between 9.7 and 12.0

Source: Pollen.com. *30 Day historic allergy and pollen levels*. Retrieved October 4, 2010, from http://www.pollen.com/historic-pollen-levels.asp

1. What are the different types of pollen that can cause seasonal allergies?

2. What is the meaning of “pollen count?” Describe at least one method that researchers use to measure pollen levels.

3. List different factors that can cause changes in pollen count level.

Pollen Count Levels and Allergies

The data below show pollen count levels for Long Island City, Queens, N.Y. for 10 days between September 5, and September 17, 2010. Use the chart below to answer questions 4-7.

Pollen History

Date	Day	Pollen Count Level
9/5/10	1	9.5
9/7/10	3	8.6
9/9/10	5	7.8
9/11/10	7	6.5
9/12/10	8	2.8
9/13/10	9	5.2
9/14/10	10	6
9/15/10	11	5.7
9/16/10	12	3.3
9/17/10	13	1.3

Source: Pollen.com. *30 Day historic allergy and pollen levels*. Retrieved October 4, 2010, from http://www.pollen.com/historic-pollen-levels.asp

4. Observe the pattern. On what day was the pollen count the highest? What was the level? On what day was the pollen count the lowest? What was the level?

5. In the *x*-*y* coordinate plane, if *x* represents the Day and *y* represents the Pollen Count Level for that day, write the set of all ordered pairs from the chart. Plot these points to create a scatter plot. (Do not connect the points.) What relationship does the graph suggest between the day and the pollen count level?

6. Choose points (1, 9.5) and (7, 6.5) to find the slope of the line passing through these points. What is the sign of slope value? How can you relate that to the pattern you observed?

7. Find the equation of the line passing through these points in question 6. Put your answer in the form $y = mx + b$.

8. Use the equation found in your answer to question #7 to complete the chart below: (Hint: September 5 = Day 1, September 6= Day 2, September 7 = Day 3 & so on)

Date	9/13/10	9/16/10	9/24/10	9/26/10	9/30/10
Day # X	9	12	20	22	26
Pollen count level Y					

9. Observe the predicted values that you found for September 26 and September 30 in the chart above. Are these values meaningful?

10. Do you think a straight-line equation could predict the pollen count for any day of the year? Why or why not? Explain your answer.

11. Why should we watch pollen count levels? How do high pollen counts affect people with pollen allergies?

12. What can we do to prevent health problems related to pollen? List two actions that should be taken by anyone with pollen allergies.

Handout#2: Quadratic Equations

Kothari | Elementary Algebra – Problems and Issues in Public Health (MAT096)

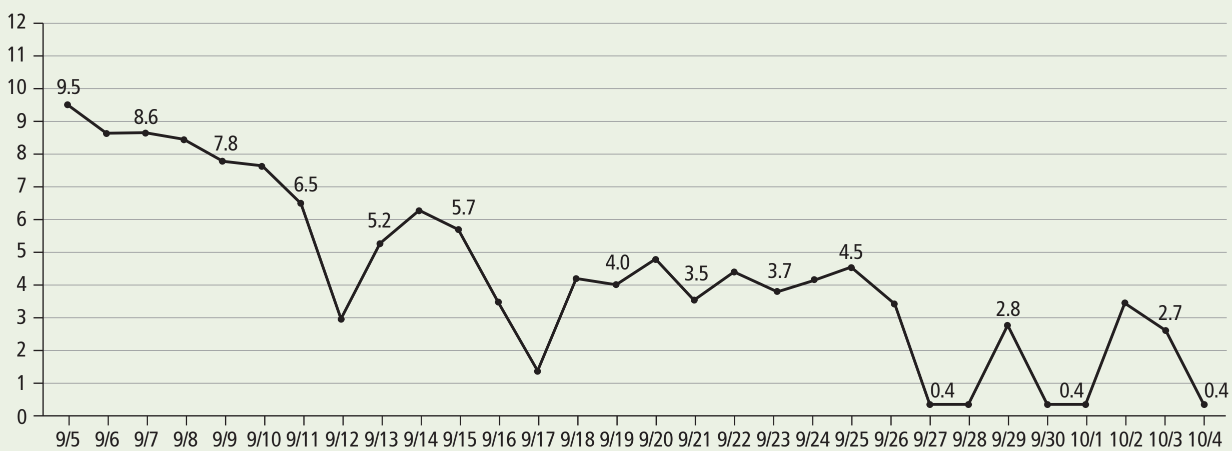
Introduction

Equations of the type are called quadratic models. From statistical data given in the form of a chart, one can graph the points to make a scatter plot. If we connect a maximum number of the points (note that at least three points are needed to fit a curve), we get an upside-down opening curve called a parabola. Using algebraic techniques or graphing utilities, we can find the equation that represents this curve. In question number 3 below, you are given the equation of the curve that best fits the given data. Please read the data carefully and answer the following questions. Also, keep your answers from Activity 1 handy for easy comparison.

Questions

The graph below is the pollen count history for Long Island City, NY, from September 5, 2010 to October 4, 2010.

30 Day History for Long Island City, NY



Source: Pollen.com. *30 Day historic allergy and pollen levels*. Retrieved October 4, 2010, from http://www.pollen.com/historic-pollen-levels.asp

1. Refer to the graph above to answer the following questions:
   a. On what day was the pollen count the highest?

   b. On what day was the pollen count the lowest?

   c. During what period of the month was the pollen count level between 6.5 and 9.5?

2. Plot the points given in the “Pollen History” chart in Activity 1. Join all the points from September 12, 2010 to September 17, 2010 to make a prabola. What form of the parabola do you observe? Is it opening upwards or downwards?

3. Suppose the function $f(x) = -0.6214x^2 + 12.664x - 58.6$ represents the equation of the graph you found in question 2 above. Calculate $f(5)$, $f(10)$, $f(12)$, and $f(15)$ to one decimal place. (Note that $f(5)$, $f(10)$, $f(12)$, and $f(15)$ and represent the pollen count levels for 9/9/10, 9/14/10, 9/16/10, and 9/19/10 respectively). Complete the following chart. Use your calculator to check the values you found.

Date	**9/9/10**	**9/14/10**	**9/16/10**	**9/19/10**
Day # X	5	10	12	15
Pollen Count Level Y $f(x) = -0.6214x^2 + 12.664x - 58.6$				

4. Are the values for Day 5 and Day 15 meaningful? Explain why or why not.

5. Do you think the above quadratic equation would work in predicting pollen levels for the month of October? Would it work better for finding pollen levels for any other time of the year? Explain your answer.

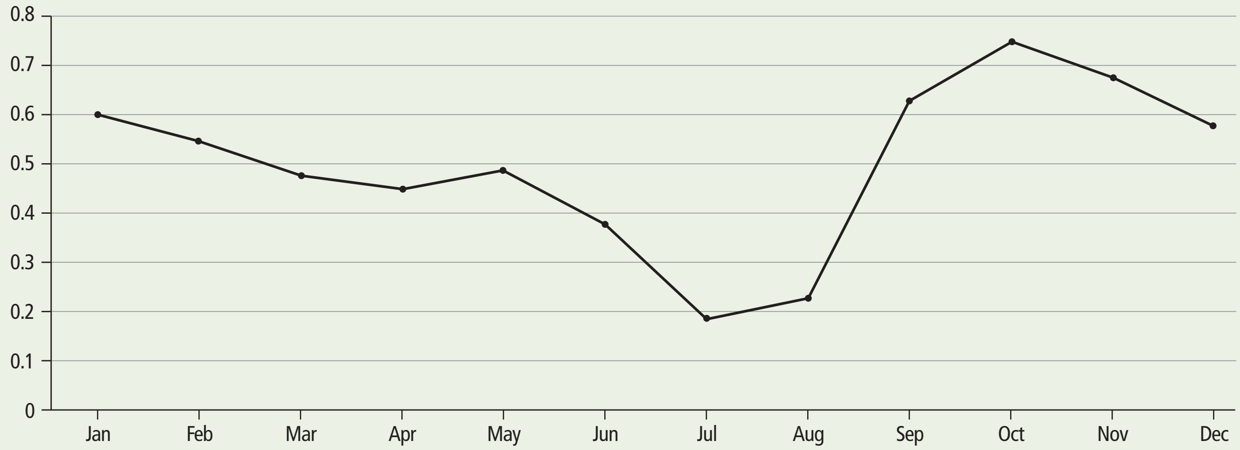
6. Compare these three sets of pollen counts using: the linear model in Handout #1; the quadratic model in Handout #2; and the values indicated on the graph in question 1 above. Which model is a better predictor of pollen counts? Write your comments. (Hint: Complete the chart below to interpret your observations.)

Date	**9/9/19**	**9/13/10**	**9/16/10**	**9/19/10**	**9/26/10**
Day # X	5	9	12	15	22
Pollen Count level (Using Linear Model)					
Pollen Count level (Using Quadratic Model)					
Pollen Count level (from graph)					

7. Do you think meteorologists can always depend on either the linear or quadratic model to predict the pollen count throughout the year? Is time of year the only factor we should use to predict pollen levels? Are there other factors that may affect pollen levels? Use information from the website to support your answer.

8. We know that millions of people suffer from allergies and asthma each year. The following graph represents the incidence of asthma-related hospitalizations of New York City children aged 0-14 over the calendar year. Using the charts, what you have learned from our discussions, and the work you did on Handout #1 and Handout #2, answer the questions below.

Hospital Admission for Asthma By Month and Age, New York City, 2000



Source: Graph adapted from data at New York City Department of Health and Mental Hygiene Childhood Asthma Inititiative. (2003, May). Asthma Facts. Pages 18 and 44. Retrieved November 4, 2010 from http://www.nyc.gov/html/doh/downloads/pdf/asthma/facts.pdf

- In which month was the rate of hospital admissions the highest?
- How do asthma hospital admissions relate to the pollen count levels for particular times of the year shown in the graph in "30 Day History for Long Island City, NY"?
- In which month was the rate of hospital admissions the lowest?

9. Writing Task: Use the information on the Allergy and Asthma Foundation of America website (http://www.aafa.org/) to learn about how high pollen levels can cause allergies that could trigger asthma attacks. Then, write a letter to a parent explaining the relationship between pollen, allergies and asthma. Make suggestions to parents about how to avoid or treat these problems.

Reading: Pollen and Mold Counts

Kothari | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Source: Allergy and Asthma Foundation of America. *Pollen and mold counts*. Retrieved October 4, 2010, from http://www.aafa.org/display.cfm?id=9&sub=19&cont=264

A sure sign of spring (or summer or fall) in many regions of the United States is news media reports of pollen counts. These counts are of interest to some 35 million Americans who get hay fever because they are allergic to pollen.

People also look for counts of mold or fungus spores. These are another major cause of seasonal allergic reactions. Pollen and mold counts are important in helping many people with allergies plan their day.

What Is the Pollen Count?

The pollen count tells us how many grains of plant pollen were in a certain amount of air (often one cubic meter) during a set period of time (usually 24 hours). Pollen is a very fine powder released by trees, weeds and grasses. It is carried to another plant of the same kind, to fertilize the forerunner of new seeds. This is called pollination.

The pollen of some plants is carried from plant to plant by bees and other insects. These plants usually have brightly colored flowers and sweet scents to attract insects. They seldom cause allergic reactions. Other plants rely on the wind to carry pollen from plant to plant. These plants have small, drab flowers and little scent. These are the plants that cause most allergic reactions, or hay fever.

When conditions are right, a plant starts to pollinate. Weather affects how much pollen is carried in the air each year, but it has less effect on when pollination occurs. As a rule, weeds pollinate in late summer and fall. The weed that causes 75 percent of all hay fever is ragweed which has numerous species. One ragweed plant is estimated to produce up to 1 billion pollen grains. Other weeds that cause allergic reactions are cocklebur, lamb's quarters, plantain, pigweed, tumbleweed or Russian thistle and sagebrush.

- Trees pollinate in late winter and spring. Ash, beech, birch, cedar, cottonwood, box, elder, elm, hickory, maple and oak pollen can trigger allergies.
- Grasses pollinate in late spring and summer. Those that cause allergic reactions include Kentucky bluegrass, timothy, Johnson, Bermuda, redtop, orchard, rye and sweet vernal grasses.

Much pollen is released early in the morning, shortly after dawn. This results in high counts near the source plants. Pollen travels best on warm, dry, breezy days and peaks in urban areas midday. Pollen counts are lowest during chilly, wet periods.

What Is the Mold Count?

Mold and mildew are fungi. They differ from plants or animals in how they reproduce and grow. The "seeds," called spores, are spread by the wind. Allergic reactions to mold are most common from July to late summer.

Although there are many types of molds, only a few dozen cause allergic reactions. Alternaria, Cladosporium (Hormodendrum), Aspergillus, Penicillium, Helminthosporium, Epicoccum, Fusarium, Mucor, Rhizopus and Aureobasidium (pullularia) are the major culprits. Some common spores can be identified when viewed under a microscope. Some form recognizable growth patterns, or colonies.

Many molds grow on rotting logs and fallen leaves, in compost piles and on grasses and grains. Unlike pollens, molds do not die with the first killing frost. Most outdoor molds become dormant during the winter. In the spring they grow on vegetation killed by the cold.

Mold counts are likely to change quickly, depending on the weather. Certain spore types reach peak levels in dry, breezy weather. Some need high humidity, fog or dew to release spores. This group is abundant at night and during rainy periods.

What Are the Symptoms for Hay Fever?

Pollen allergies cause sneezing, runny or stuffy nose, coughing, postnasal drip, itchy nose and throat, dark circles under the eyes, and swollen, watery and itchy eyes. For people with severe allergies, asthma attacks can occur.

Mold spores can contact the lining of the nose and cause hay fever symptoms. They also can reach the lungs, to cause asthma or another serious illness called allergic bronchopulmonary aspergillosis.

Pollen Count Levels and Allergies

How Are Pollen and Mold Measured?

To collect a sample of particulates in the air, a plastic rod or similar device is covered with a greasy substance. The device spins in the air at a controlled speed for a set amount of time— usually over a 24-hour period. At the end of that time, a trained analyst studies the surface under a microscope. Pollen and mold that have collected on the surface are identified by size and shape as well as other characteristics. A formula is then used to calculate that day's particle count.

The counts reported are always for a past time period and may not describe what is currently in the air. Some counts reflect poorly collected samples and poor analytical skills. Some monitoring services give "total pollen" counts. They may not break out the particular pollen or mold that causes your allergies. This means that allergy symptoms may not relate closely to the published count. But knowing the count can help you decide when to stay indoors.

How Can I Prevent a Reaction to Pollen or Mold?

Allergies cannot be cured. But the symptoms of the allergy can be reduced by avoiding contact with the allergen.

- Limit outdoor activity during pollination periods when the pollen or mold count is high. This will lessen the amount you inhale.
- The National Allergy Bureau (NAB) tracks pollen counts for different regions of the country. Contact the NAB through the American Academy of Allergy, Asthma and Immunology website.
- Pollen.com is also a reliable source of "pollen forecasts" in your zip code area, maintained by Surveillance Data Inc., a national monitor of medical and environmental statistics.
- Use central air conditioning set on "recirculate" which exclude much of the pollen and mold from the air in your home.
- Vacationing away from an area with a high concentration of the plants that cause your allergies may clear up symptoms. However, if you move to such an area, within a few years you are prone to develop allergies to plants and other offenders in the new location.

SOURCE: This information should not substitute for seeking responsible, professional medical care. First created 1995; fully updated 1998; most recently updated 2005.

Swine Flu – H1N1

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Project Quantum Leap

Objectives

The goal of this activity is to have students apply their knowledge of quadratic functions and functional notation to propose a mathematical model of the H1N1 swine flu epidemic in the U.S. between April and May, 2009. Students will use that model to make predictions about swine flu, and will come to understand both the advantages and the limitations of mathematical models in predicting the behavior of a real life phenomenon such as swine flu.

Math Topics
Functional notation; quadratic function; zero factor property

Purpose
Motivation

Duration
About 90 minutes (50 minutes at home, 40 minutes in class discussion)

Activity Time Frame
Two weeks

Reflection

H1N1 is an influenza virus usually found in pigs, but which can also both infect and become infectious in humans. The virus can also change, or mutate. In the spring of 2009, cases of H1N1 flu virus were first discovered and confirmed in Mexico, and then in the United States. Since people were not immune to it, this virus spread very quickly. The number of people infected dropped in the summer of 2009; unfortunately, a new epidemic in the U.S. began in the fall of 2009. The data about the epidemic of the virus in the spring of 2009 is discussed at the website: https://health.google.com/health/ref/H1N1+(swine)+influenza.

In the introductory phase of the class activity, students learned how to manipulate a variable using whole numbers. The independent variable, days of spring in 2009, was converted from the date format to integers starting at zero, with April 23, 2009 as the reference day. Students were also introduced to the concept of mathematical (quadratic) modeling by studying the quadratic model obtained after correlating the data. Students observed that when comparing real data to data obtained from mathematical models, the results differed. They were asked to think about the possible reasons for that difference. They were also asked to analyze the quadratic equation that models the data. The sign of the quadratic coefficient and the missing term (the constant term of the quadratic equation) were discussed and explained.

Students' comments provided rewarding feedback:

> "It never occurred to me that math is used in other areas of our daily lives."
>
> "If I learn the rules and understand math better I will come to appreciate it."
>
> "After I looked at and read the problem carefully it stopped blocking my mind and I could see that it is possible to solve math problems."

These comments are the best evidence of the power of such an activity to transform the students' apathy, fear and probably phobia of math into a positive force for learning.

Activity Overview

This activity should be introduced after teaching graphs of quadratic functions, and students have one week to complete it.

First lesson (30 minutes in class): The instructor distributes the handout and provides a brief overview of the issues related to swine flu and its impact on society. The class discusses Figure1. The instructor explains how the data is summarized in Table 1 by shifting the independent variable. Then, the instructor describes the prediction equation and the shape of the function in Figure 2. All necessary information is included in the three page handout given to the students. Students should carefully read the handout at home.

Day 1 of the following week (10 minutes in class): Give the students the opportunity to ask questions arising from their careful reading of the handout at home. Remind them that office hours are available to answer additional questions. Emphasize the importance of completing the short reflection (on page 3 of the handout), as a means of processing the activity. The assignment is due the following day.

Materials and Resources

1. Handout
2. World Health Organization. www.g2weather.com/g2_weather/2009/05/swine-flu-graph-confirmed-us-cases-since-april-23rd.html. Last retrieved April 2, 2010. This site does not exist now. It contained the graph and numbers of flu cases in the U.S. The data and graph were derived from raw WHO data that can be found at http://www.who.int/csr/disease/swineflu/updates/en/index.html
3. Google Health. (2009, July 29.) *H1N1 (swine) influenza*. Retrieved Apr. 18, 2010, from https://health.google.com/health/ref/H1N1+(swine)+influenza.

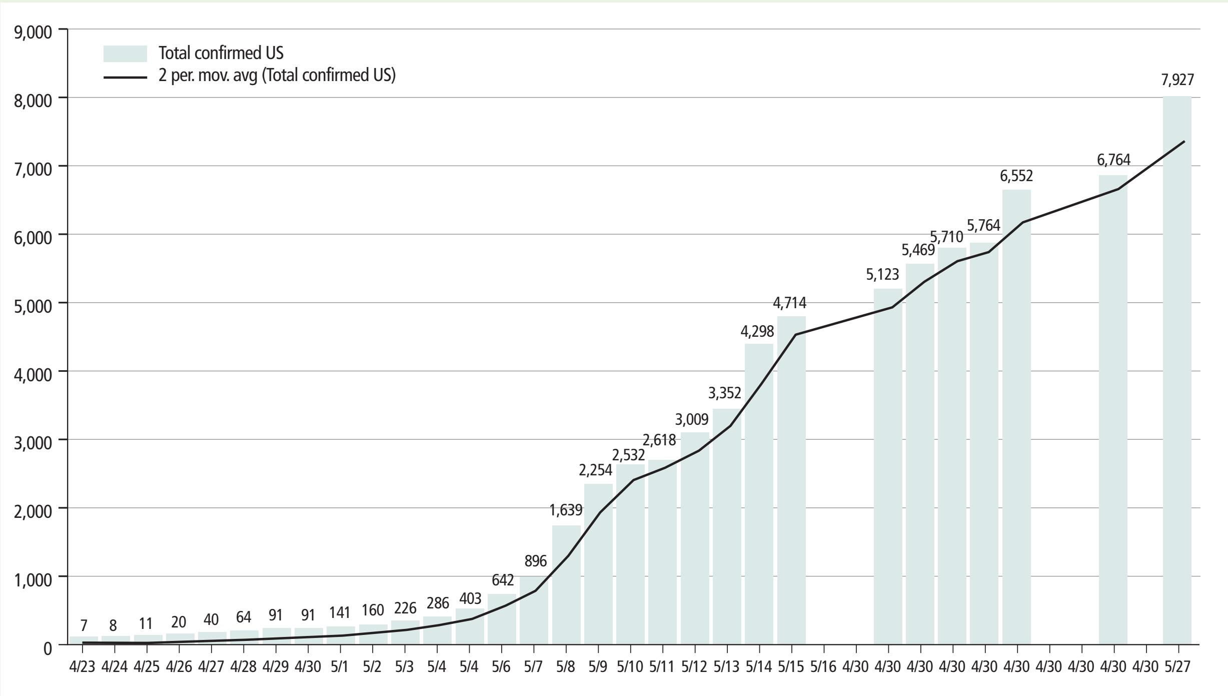
Handout

Przhebelskiy | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Objective

The goal of this activity is to apply algebra concepts to propose a quadratic function as a mathematical model of the swine flu cases in the U.S. and use that model to predict the number of swine flu cases.

Figure 1: Swine Flu confirmed U.S. cases as of May 27, 2009



Source: "Swine Flu Graph: 7927 Confirmed US Cases as of May 27, 2009" http://www.g2weather.com/g2_weather/2009/05/swine-flu-graph-confirmed-us-cases-since-april-23rd.html

Figure 1 presents the confirmed cases of swine flu in US as of May 27, 2009.

Table 1 presents the dates and the number of swine flu cases, where x is the number of days after April 23, 2009, and y is the number of flu cases on day x.

Note that the number of days is taken with the day April 23, 2009 as the reference date.

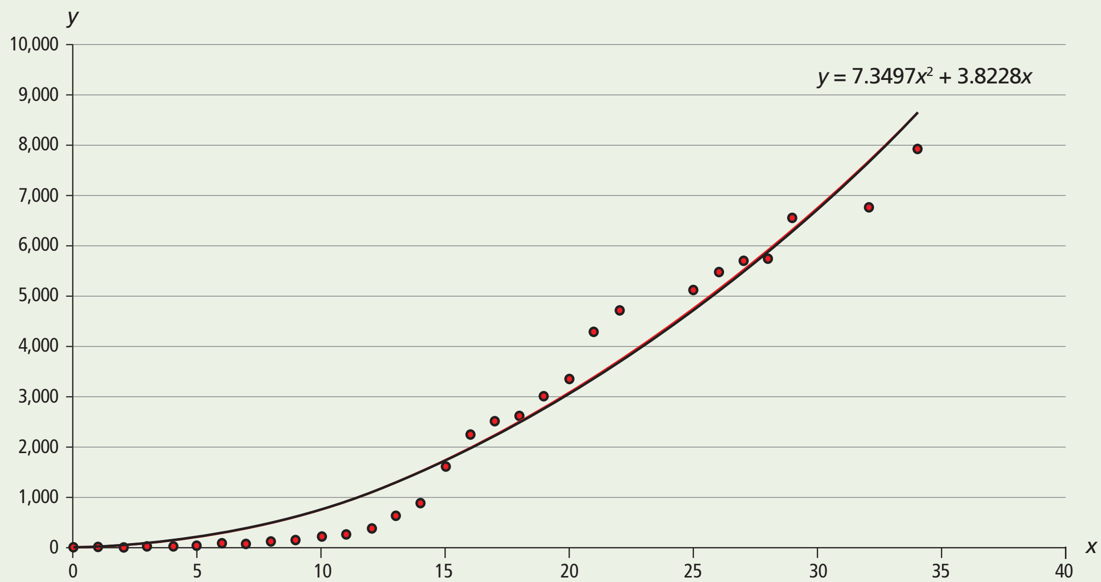
Points (x, y) are plotted in Figure 2. From Figure 2 it is apparent that the data does not follow a linear behavior. We shall use the quadratic function $y = ax^2+bx+c$ to approximate it.

Using Excel or a TI-83 calculator, the x and y data in Table 1 can be approximated to a quadratic model. The equation is $y = 7.3497x^2+3.8228x$. The plot of the quadratic function is also depicted in Figure 2.

Table 1: Swine flu data from Figure 1

Date	x = number of days after April 23	y = number of cases
23-Apr	0	7
24-Apr	1	8
25-Apr	2	11
26-Apr	3	20
27-Apr	4	40
28-Apr	5	64
29-Apr	6	91
30-Apr	7	91
1-May	8	141
2-May	9	160
3-May	10	226
4-May	11	286
5-May	12	403
6-May	13	642
7-May	14	896
8-May	15	1639
9-May	16	2254
10-May	17	2532
11-May	18	2618
12-May	19	3009
13-May	20	3352
14-May	21	4298
15-May	22	4714
18-May	25	5123
19-May	26	5469
20-May	27	5710
21-May	28	5764
22-May	29	6552
25-May	32	6764
27-May	34	7927

Figure 2: Real data and quadratic model proposed



Apply your knowledge about quadratic functions and functional notation to answer the following questions:

1. (10 pts) Using the function $y = 7.3497x^2+3.8228x$, determine how many flu cases were reported on May 14, 2009. Hint: Remember that for this date x=21. Calculator required.

2. (3 pts) Is the answer to #1 the same value in Table 1? ________ Yes ________ No

3. (7 pts) Why is there a difference?

4. (30 pts) According to the quadratic model $y = 7.3497x^2 + 3.8228x$, how many cases should be expected by June 1 2009? Calculator required.

5. (30 pts) According to the modeling equation, at what values of x does the number of cases of swine flu equal zero? Give an explanation for each value obtained.

6. (20 pts) Write a short summary of your experience with this activity: What mathematical skills did you use to solve this problem? Did this activity change how you think and feel about math? Did you ever think that swine flu and math might be related as they are in this activity? Why or why not?

References

- Google Health. (2009, July 29.) *H1N1 (swine) influenza*. Retrieved Apr. 18, 2010, from https://health.google.com/health/ref/H1N1+(swine)+influenza.

Exercise and Heart Rate

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Project Quantum Leap

Objectives

The objective of this project is to help students calculate their maximum and target heart rates, and to study the effect of exercise on heart rate. Using heart rate data obtained from the American Heart Association, students will learn to calculate slope, to construct a linear equation, and to use a linear equation to predict heart rates for subjects of different ages.

Math Topic
Plotting ordered pairs, calculating slope, graphing linear equations with two variables, and functions and relations

Purpose
Review, synthesis

Comments
These exercises are based on calculating heart rate and building linear models using heart rate data for different age groups obtained from the American Heart Association.

When to Introduce
Week 2

Activity Time Frame
Two weeks

Reflection

This project on heart rate demonstrates to students that exercise is important for overall good health and for a healthy heart. Regular exercise reduces the risk of heart disease by reducing high blood pressure, stress, overweight and obesity.

The project incorporates a reading about heart rate, giving students the opportunity to understand and ask questions about main concepts and terms. Heart rate is defined and guidelines are provided for measuring heart rate, and keeping heart rate in the target zone during exercise. This project fosters excellent interaction in class, thereby contributing to students' growing awareness of medical problems related to heart rate. It may also potentially help students to diagnose cardiovascular disease at an early stage.

My personal communication with students has given me the impression that they enjoyed measuring their target heart rates and learning about strengthening the heart by exercising.

Since heart rate or pulse depends on one's emotional state, temperature, position or posture (sitting, standing, lying down), some students preferred to measure their pulse at home upon rising in the morning, as mentioned in the reading.

Most of the students did not understand how to determine function using slope, or predict heart rate using linear equations. I first showed them how to calculate the slope of each pair. If the slope of each pair is the same, then the equation of the line is a function; otherwise, it is not.

I also helped them find their heart rate using linear equations. Students learned to create graphs showing the relationship between heart rate and increasing age, to predict heart rates for subjects of different ages using estimated linear equations, and to use slopes to determine functions.

Finally, I guided them in writing a one-page reflection based on my question in Part 3.

Activity Overview

Week one

Devote about 30 minutes of class time to a discussion of the Reading, "What You Should Know about Your Heart Rate or Pulse," about measuring pulse or heart rate and calculating maximum heart rate based on age. You can begin by asking students what they already know about the main reading topics, as listed below, and then have them read again as necessary to correct their understanding or add any information to their understanding of these concepts.

- What is Heart Rate?
- How To Measure Your Pulse
- Reducing Your Heart Rate
- Target Heart Rate
- Recovery Heart Rate

Week Two

In Part 2 of this project, students are required to calculate slope and linear equations, to plot ordered pairs, construct and interpret graphs, and to determine domain, range, function and relation.

Students work out solutions to the given mathematical problems, using slope in each pair to determine function, and linear equations to predict heart rate. Both activities are done in class with instructor guidance (45 minutes in-class time).

Materials and Resources

- Handout
- Reading: National Emergency Medicine Association. (2003). *What you should know about your heart rate or pulse.* Retrieved from http://www.nemahealth.org/programs/healthcare/heart_rate_pulse.htm
- Optional links for further exploration:
  - Heart.com. (2009). *Articles of the heart.* Retrieved from http://www.heart.com/the-heart.htm
  - Heart.com (2009). *Heart rate chart.* Retrieved from http://www.heart.com/heart-rate-chart.html
  - ProHealth. (2011). *Target heart rate.* Retrieved from http://www.prohealth.com/weightloss/tools/target-heart-rate.cfm

Handout

Rahman | Elementary Algebra – Issues in Public Health (MAT096)

The questions in Parts 1-3 are based on the Reading: "What you should know about your heart rate or pulse." Please be sure to read the article before responding to the questions below.

Part 1

1. Why is a lower pulse rate good?
2. Why might an athlete have a lower pulse rate than a person who does not exercise regularly?
3. What are some of the factors that influence heart rate?
4. What can you do you to reduce your heart rate (pulse)?
5. Calculate your maximum heart rate using the following formula:
   Maximum heart rate=220-your age.
6. a. Using your maximum heart rate, calculate your personal target heart rate .

   b. Compare your calculated personal target heart rate to those in Table 1 below.

Table 1: Target heart rates for different age groups

Age	Target Heart Rate Zone (50-85%)	Average Maximum Heart Rate (100%)
20 years	100-170 beats per minute	200 beats per minute
25 years	98-166 beats per minute	195 beats per minute
30 years	95-162 beats per minute	190 beats per minute
35 years	93-157 beats per minute	185 beats per minute
40 years	90-153 beats per minute	180 beats per minute
45 years	88-149 beats per minute	175 beats per minute
50 years	85-145 beats per minute	170 beats per minute
55 years	83-140 beats per minute	165 beats per minute
60 years	80-136 beats per minute	160 beats per minute
65 years	78-132 beats per minute	155 beats per minute
70 years	75-128 beats per minute	150 beats per minute

Source ProHealth. (2011). *Target heart rate.* Retrieved from http://www.prohealth.com/weightloss/tools/target-heart-rate.cfm

7. If the result you obtained from answering Question 6 doesn't fall within the suggested target heart rate zone closest to your age as indicated in Table 1, think about the possible reason(s) and describe in a paragraph how you can reach your target heart rate.

Part 2

The data in Table 2 below represent the maximum benefit to the heart from exercising, if the heart rate is in the target heart rate zone. In the graph, x represents different age groups and y represents the number of heart beats per minute.

Table 2: Maximum benefit to the heart from exercising

Age, x	Maximum Number of Heart Beats, y	Average (x, y)
20	140	
30	133	
40	126	
50	119	
60	112	
70	105	

Source: ProHealth. (2011). *Target heart rate*. Retrieved from http://www.prohealth.com/weightloss/tools/target-heart-rate.cfm

The American Heart Association's recommendation for achieving the maximum cardiac benefit when exercising is to start an exercise program at the lowest part of your heart rate zone and build up to your maximum heart rate. The lower limit of this zone is found by taking 50% of the difference between 220 and your age (maximum heart rate=220-age). The upper limit is found by taking 85%.

Therefore, looking at Tables 1 and 2 together, the connection is as follows:

To calculate the target heart rate zone for a 20 year-old:
220 - 20 = 200 beats per minute= Maximum Heart Rate

From Table 1

Lower Limit of Target Heart Rate Zone= 200 X 0.5 = 100

Upper Limit of Target Heart Rate Zone= 200 X 0.85 = 170

From Table 2

The maximum number of heart beats for a 20 year old is in the target heart rate zone.

Now, write the data from Table 2 as ordered pairs, create a graph of the data, and then answer the questions or solve the problems below:

1. What kind of pattern can you observe from your graph?
2. What type of relationship appears to exist between the maximum number of heartbeats and age?
3. Select any two points and find an equation of the line containing the two points.
4. Calculate slope for every pair of points. If the slopes are the same, determine whether the function is linear or not.

5. Interpret the slope of the line you found in #5 above. How do you explain that particular negative value of the slope?
6. Using the equation of the line found in #5, predict the maximum number of heartbeats for ages 25, 55, 65, and 80
7. Using the equation of the line found in #5, what is the approximate age of a person whose maximum number of heart beats is 115?
8. Does the relationship defined by the set of ordered pairs (x, y) represent a function? If yes, write the domain and range.

Part 3

Reflection:

1. Write a paragraph explaining what math you have learned from this project.
2. Why does heart rate decrease as age increases? Explain your answer in writing, in terms of the slope of the equation of the line.
3. How have the quantitative calculations you've done on heart rate data enhanced your understanding of the seriousness of this health problem? Write a letter to a future MAT096 student sharing what you know as a result of this project. Include recommendations for a healthier heart.

Here are some optional links for further exploration:

- Heart.com. (2009). *Articles of the heart*. Retrieved from http://www.heart.com/the-heart.htm
- Heart.com (2009). *Heart rate chart*. Retrieved from http://www.heart.com/heart-rate-chart.html
- ProHealth. (2011). *Target heart rate*. Retrieved from http://www.prohealth.com/weightloss/tools/target-heart-rate.cfm

Reading: What you should know about your Heart Rate or Pulse

Rahman | Elementary Algebra – Issues in Public Health (MAT 096)

Source: National Emergency Medicine Association. (2003). *What you should know about your heart rate or pulse*. Retrieved from http://www.nemahealth.org/programs/healthcare/heart_rate_pulse.htm

Knowing how to measure your heart rate or pulse, can help you to learn about your own degree of fitness and can help to detect potential medical problems that should be brought to the attention of your physician.

What Is Heart Rate?

Very simply, your heart rate is the number of times your heart beats per minute. You can measure your heart rate by feeling your pulse - the rhythmic expansion and contraction (or throbbing) of an artery as blood is forced through it by the regular contractions of the heart. It is a measure of how hard your heart is working.

Your pulse can be felt at the wrist, neck, groin or top of the foot - areas where the artery is close to the skin. Most commonly, people measure their pulse in their wrist. This is called the radial pulse.

How To Measure Your Pulse

Taking your pulse is easy. It requires no special equipment, however, a watch with a second hand or digital second counter is very helpful.

1. Turn the palm side of your hand facing up.
2. Place your index and middle fingers of your opposite hand on your wrist, approximately 1 inch below the base of your hand.
3. Press your fingers down in the grove between your middle tendons and your outside bone. You should feel a throbbing - your pulse.
4. Count the number of beats for 10 seconds, then multiply this number by 6. This will give you your heart rate for a minute.

Example:

If you count **12 beats** in the span of **10 seconds**, multiply **12 X 6 = 72**. This means your Heart Rate or pulse, is **72** (or 72 beats per minute).

Another popular way to measure pulse rate is by measuring it at the neck (carotid pulse). This is especially convenient during exercise. The formula is the same as above, however, when taking the pulse at the neck, place your fingertips gently on one side of your neck, below your jawbone and halfway between your main neck muscles and windpipe.

Taking your pulse upon rising in the morning, or after sitting without activity for about 10 minutes, is known as your Resting Heart Rate.

What Is A Normal Heart Rate?

A Resting Heart Rate anywhere in the range of 60 - 90 is considered in the normal range. Your Heart Rate will fluctuate a lot depending on such factors as your activity level and stress level. If however, your pulse is consistently above 90, you should consult with your physician. This condition is called tachycardia (increased heart rate).

Many athletes have pulse rates in the 40 - 60 range, depending on how fit they are. In general, a lower pulse rate is good. Sometimes however, one's heart rate can be too low. This is known as bradycardia and can be dangerous, especially when blood pressure gets too low as well. Symptoms include weakness, loss of energy and fainting. If this situation applies, medical attention should be sought immediately.

If the pattern of beats or throbs you count is irregular (i. e. a beat is missed) take your pulse for a full minute. If you experience irregularities in your pulse on a consistent basis, you should consult with your personal physician.

Many factors influence heart rate. These include emotions, temperatures, your position or posture (sitting, standing, laying down), and your body size (if you are overweight for your size, your heart will have to work harder to supply energy to your body).

Reducing Your Heart Rate

A decrease in resting heart rate is one of the benefits of increased fitness due to exercise. Before starting into any exercise regimen, however, be sure to consult with your personal physician.

Your heart is a muscle and will respond just like any skeletal muscle in that it will become stronger through conditioning. If your heart muscles are stronger, then your heart rate will decrease. In other words, your heart will be putting out less effort to pump the same amount of blood.

Target Heart Rate

When undertaking an exercise program it is important to have a goal and a target range that you are trying to accomplish in each workout. To be of benefit, you want the workout to be neither too hard nor too easy. There is a simple formula to predict your maximum heart rate that is used in the fitness industry:

Take 220 and subtract your age.

This will give you a predicted maximum heart rate.

For example, if you are **42 years old**, subtract 42 from 220 (**220 - 42 = 178**). This means that your maximum physiological limit as to how fast your heart should beat is **178** beats per minute.

Most exercise programs suggest that when someone is just getting started that their heart rate during exercise should not exceed 60 - 70% of their maximum heart rate. Therefore, given the example above, 60% of 178 = 107 beats per minute. As you progress in your exercise, the percentage of your maximum heart rate to be set as a goal can be gradually increased.

Calculating a target heart rate zone is often desirable. To do so:

1. Start with your maximum heart rate as shown above.
2. Multiply your maximum heart rate by 0.8 to determine the upper limit of your target heart rate zone (divide this product by 6 to get the rate for a ten-second count).
3. Multiply your maximum heart rate by 0.6 to determine the lower limit of your target heart rate zone (divide this product by 6 to get the rate for a ten-second count).

Example:
For a person **42 years old**:

220 - 42 = **178 Maximum Heart Rate**

178 X 0.8 = **142 Upper Limit of Target Heart Zone** (142/6 = 24,10 sec. count)

178 X 0.6 = **107 Lower Limit of Target Heart Zone** (107/6 = 18, 10 sec. count)

Note: Your maximum heart rate is the most your heart should reach after a strenuous workout.

Your Heart Rate should be measured during warm-up, halfway into your workout, at the end of your workout and at the end of your cool-down period. If during exercise you exceed your upper limit, decrease the intensity of your workout. Conversely, at the end of your workout if your heart rate is much lower than your target, you need to work harder next time.

Recovery Heart Rate
One way to determine if you are reaping the benefits from exercise is to calculate your Recovery Heart Rate, a measure of how quickly you return to your resting heart rate after a workout. To calculate your recovery heart rate:

1. Take your pulse ten seconds immediately after you have finished exercising. Write down the number.
2. One minute later, take your pulse again and write it down.
3. Subtract the number for the second pulse check from the number for the first pulse check. This number is your Recovery Heart Rate. The greater the number, the better shape you are in!

A Final Word on Exercise Programs
Exercise programs help to increase the strength of the heart. Declines will be seen in resting heart rate, and hopefully, blood pressure, and stress levels as well. Overall body changes will also be experienced including weight loss and increase of lean body mass.

Remember, however, that it is important to check with your doctor and seek out a qualified exercise physiologist before your get started. An exercise stress test may be advised to help ensure the training parameters that are best for you.

The Mathematics of Mass Vaccination

Vladimir Przhebelskiy
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

The goal of this activity is to have students apply algebraic concepts in order to understand how vaccination helps manage and eradicate infectious diseases. Students will learn how the rate of infection is described mathematically by a basic reproduction number. Using linear function, they will calculate how the vaccination of a population slows the rate of infection and helps eradicate infectious diseases.

Motivated students may want to consult http://en.wikipedia.org/wiki/Infectious_disease to deepen their knowledge of infectious diseases, and http://encyclopedia.thefreedictionary.com/Vaccination, to further their understanding of the history and mechanism of vaccination.

Math Topic
Graphing linear equations, finding the slope of a line, and solving linear inequalities

Purpose
To improve student motivation and understanding by presenting mathematics through the context of its public health applications

Duration
About 90 minutes (40 minutes at home, 50 minute in- class discussion)

When to Introduce
Weeks 4–5

Activity Time Frame
2 weeks

Reflection

The recent outbreak of the H1N1 (swine) flu offers educators a perfect opportunity to introduce the mathematical modeling of vaccinations which combat infectious diseases.

While the biologist analyzes the composition of a particular virus and tries to create a vaccine to combat the resulting disease, it is the mathematician who allows scientists to understand how virulent that virus is (Du Sautoy, M. 2009).

The classic SIR model for the spread of an epidemic, representing the three primary states that any member of a population can occupy with respect to a disease: susceptible, infectious, and removed, requires knowledge of nonlinear differential equations (Smith, D. and Moore, L. 2001; and Wang, F. 2010).

This project, however, focuses only on the application of elementary algebra to the analysis of infectious diseases; in particular, on vaccination and its potential to control and eradicate infectious diseases. Adopting this material as a project in an elementary algebra course affords students the opportunity to learn mathematics through the examination of current and urgent public issues.

When surveyed about this project, students provided rewarding feedback. Their comments are quoted, verbatim, below:

- "This project helped me to analyze data carefully and logically. I understand now how math is applied in science, technology and that it is very commonly used to explain and demonstrate a variety of situations."
- "This activity changed a lot my point of view about math. Cause I never realized that thank to math many diseases can be cured and less people are killed because of these diseases."

- "This activity changed the way I used to think about math because with math we can find many solutions just like we did in this project."
- "I used to hate math and now I did not hate it as much. This project helped me become more comfortable when solving equations and interpreting graphs."
- "I now do see how math can be involved into anything. How you can put an everyday problem and involve it into math. "
- "The professor really tried to help me understand math, I will attempt to use math more in my day to day event."

Activity Overview

By the end of Week 3, students will have learned different ways of graphing a line and working with its slope. This project can be introduced in week 4, and completed in two weeks.

Note: The effect of vaccination is described in the two sources below:
a. The article, "Reproductive Number" (2009, August 1), retrieved from the Ganfyd website: http://www.ganfyd.org/index.php?title=Reproductive_number), is required reading for students, and is part of the handout;

b. Lecture "Concepts for the prevention and control of microbial threats – 2". Center for Infectious Disease Preparedness, UC Berkeley School of Public Health is recommended but not required reading

The **basic reproduction number** (R_0) refers to the number of secondary infectious cases that would be produced by a single infectious case introduced into a completely susceptible population with no control measures. For a given population, a communicable microbe has an expected R_0. R_0 allows us to compare the potential for different microbes to cause outbreaks/epidemics in a population.

As an epidemic evolves, the average number of secondary cases produced by infectious cases generally declines as people die out or become immune to the disease. This is called the **effective reproduction number**.

In the presence of control measures, the effective reproduction number is called the **control reproduction number**. The goal in infectious disease control is to get the control reproduction number down to less than 1 as quickly and as cost effectively as possible.

The control reproduction number (R_c) is given by the following equation:
$R_c = R_0\,(1 - h\,f)$ where ***h* is the vaccine efficacy** (the proportion of people vaccinated who will have complete protection), and ***f* is the vaccine coverage** (proportion of the population that has been vaccinated).

In this project, it is assumed for simplicity that vaccine efficacy $h = 1$, which results in Equation 2 in the handout: $R_c = R_0 - R_0\,f$

Also, according to the Ganfyd website, (http://www.ganfyd.org/index.php?title=Reproductive number), if the goal of a vaccination program is to eliminate a disease (or, to put it another way, to ensure that there is "herd immunity"), the vaccine coverage that is required is given by the following inequality: Goal: $R_c < 1$

This inequality is used in the project to find the proportion of a population that must be immunized in order to eradicate a given communicable disease.

Lesson 1 (30 minutes in class):
Distribute the handout and provide an overview of the issues related to the basic reproduction number. Have students choose an infectious disease from Table 1 and calculate the average value of the basic reproduction number (R_0) for that disease. Then show students how to write the linear equation which demonstrates how the vaccination of a population changes the reproduction number R_0 to the new value R_c. Explain the work the students must do with the equation: find the slope of the line and graph the equation. At the end of the project, by solving the linear inequality, students will determine what percentage of the population needs to be vaccinated in order to immunize the entire population against a given infectious disease.

Lesson 2
The following week (20 minutes in class): Give students the opportunity to ask questions arising from their careful reading of the handout at home. Remind them that you are available during office hours to answer any additional questions. Emphasize the importance of completing the reflection (Step 5 of the Handout), as a means of processing the activity. The assignment is due the following day.

Materials and Resources

- Handout
- Reading: Reproductive number. (2009, August 1). Retrieved from the Ganfyd website: http://www.ganfyd.org/index.php?title=Reproductive_number

Additional reading materials:

- Basic reproduction number. Retrieved from The Free Dictionary website: http://encyclopedia.thefreedictionary.com/Basic+reproduction+number
- du Sautoy, M. (2009, June 17). Sexy maths: Arithmetic eases swine flu. *The Times*. http://technology.timesonline.co.uk/tol/news/tech_and_web/article6512745.ece
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Handout: The Mathematics of Mass Vaccination

Przhebelskiy | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Objective

In this activity, you will apply algebraic concepts in order to discover how vaccination helps control and eradicate infectious diseases. You will perform mathematical calculations involving graphing lines, finding the slope of a line, and solving linear inequalities.

Directions

Step 1: Background Information

Read about the Reproduction Number in the article from the Ganfyd website provided below. This reading is also available at http://www.ganfyd.org/index.php?title=Reproductive_number.

When you read this material, you must make sure you understand the term "herd immunity." "Herd immunity (or community immunity) describes a form of immunity that occurs when the vaccination of a significant portion of a population (or herd) provides a measure of protection for individuals who have not developed immunity." For more information, see http://en.wikipedia.org/wiki/Herd_immunity.

To demonstrate your understanding of the following concepts, think of an infectious disease that you know about. For each of the terms below, write a phrase to define each term in the context of the infectious disease you selected:

a. What is the meaning of "herd immunity"?

b. What is the basic reproduction number?

c. What is the effective reproduction number?

d. What is the control reproduction number?

Step 2: Definition of the Basic Reproduction Number R_0

According to the Free Dictionary entry about the basic reproduction number, available at (http://encyclopedia.thefreedictionary.com/Basic+reproduction+number), each virus causing an infectious disease is assigned a number called the basic reproductive rate of infection, or basic reproduction number. The basic reproduction number, R_0, measures how quickly the virus spreads, or, in other words, the number of individuals in an entirely susceptible population who will be infected by an infected person. Table 1 below shows the values of basic reproduction numbers for different infectious diseases.

These measures are useful because they help determine whether or not an infectious disease can spread through a population. When $R_0 < 1$, the infection will die out in the long run (provided infection rates are constant). But if $R_0 > 1$, the infection will spread throughout the population.

Table 1 Reproduction numbers, R_O, for different infectious diseases

Disease	Transmission	R_O	Disease	Transmission	R_O
HIV/AIDS	Sexual contact	2–5	Pertussis	Airborne droplet	12–17
Diphtheria	Saliva	6–7	Polio	Fecal-oral route	5–7
Influenza (1918 pandemic strain)	Airborne droplet	2–3	Rubella	Airborne droplet	5–7
Measles	Airborne	12–18	SARS	Airborne droplet	2–5
Mumps	Airborne droplet	4–7	Smallpox	Social contact	6–7

Source: Basic reproduction number. Retrieved from The Free Dictionary website: http://encyclopedia.thefreedictionary.com/Basic+reproduction+number

Task

Choose an infectious disease from Table 1 and calculate the average value of the basic reproduction number, R_0, for that disease. Use this value of R_0 to complete Step 3 below.

Step 3: How can the mass vaccination of a population reduce the danger of infectious disease?
Suppose that a proportion of the population, f, is immunized against a given infection with a basic reproduction number, R_0. Being a proportion, f values range from 0 to 1, where $f = 0$ means that no one is vaccinated and $f = 1$ means that the entire population is vaccinated.

According to the "Reproduction Number" article on the Ganfyd website that you read, (http://www.ganfyd.org/index.php?title=Reproductive_number), the control reproduction number is given by the following equation:

Equation 1: $R_c = R_0\,(1 - h\,f\,)$

where the control reproduction number (R_c) is the average number of secondary cases caused by each infectious case in the presence of control measures such as vaccination; h is the *vaccine efficacy* (the proportion of people vaccinated who will have complete protection), and f is the *vaccine coverage* (proportion of the population that has been vaccinated).

In this project, it is assumed for simplicity that vaccine efficacy h=1. Thus, the proportion of the population that is vaccinated, the original reproduction number and the control reproduction number can be related as follows:

Equation 2: $R_c = R_0 - R_0\,f$

Step 3a: Substitute the vaccine efficacy $h = 1$ in Equation 1 and derive Equation 2.

Step 3b: Substitute the value of R_0 which you found in Step 2 into Equation 2, and write the resulting equation.

Step 3c: Now, change f to **x** and R_c to y in the equation set in Step 3b.

Step 3d: Find the intercepts of the equation obtained in Step 3c. Use the intercepts to sketch the line.

Step 3e: Identify the slope of the equation of the line set in Step 3c.

Step 4. Vaccine Coverage Level.
Remember, when R_c is less than 1,

Inequality 1: $R_c < 1$

the given disease will die out, and the population will achieve the herd immunity.

The inequality to find the required immunization of a population can be found by substituting the expression for R_c from the Equation 2 into Inequality 1:

Inequality 2: $R_0 - R_0 f < 1$

where: R_0: basic reproduction number
f: proportion of population which must be vaccinated.

Step 4a: Now, solve linear Inequality 2 for f, to determine the proportion of the population that must be immunized by vaccination in order to eradicate the given infectious disease. Use the value of the reproduction number R_0 you used to answer questions in Step 3.

Step 5. Reflection
What mathematical skills did you use to solve this problem? Did this activity change the way you think and feel about learning and using math? Explain your answer in two paragraphs.

Reading: The Reproduction Number

Przhebelskiy | Elementary Algebra – Problems and Issues in Public Health (MAT 096)

Source: Reproductive number. (2009, August 1). Retrieved from the Ganfyd website: http://www.ganfyd.org/index.php?title=Reproductive_number

Introduction

The reproduction number is a concept in the epidemiology of infectious diseases. It is a measure of how infectious a disease is, and is required if you wish to calculate how many people you need to vaccinate if you are to achieve herd immunity.

When somebody gets an infectious disease, they may pass it on to nobody else, or they may infect 1, 2, or more other people (who become secondary cases). This can be displayed in a number of ways, including graphically. The reproduction number, R, is the average (mean) number of secondary cases caused by each case of an infectious disease, during the infectious period.

The R number will, of course, depend on a large number of factors, including:

- How the infectious organism is spread;
- Behaviours which affect the likelihood of spread (social mixing, sexual and feeding practices...);
- The level of susceptibility within the population - which will depend on factors such as:
  - prior immunity;
  - levels of nutrition and immune suppressions;
  - age
- R_0, R, and R_C

The basic reproduction number – R_0

Basic reproductive rate (*R_0*, basic reproduction number, basic reproductive ratio) is the expected number of secondary cases produced by a typical primary case in an entirely susceptible population. When $R_0 < 1$ the infection will die out but any value for $R_0 \geq 1$ implies it will spread (without control measures) and higher numbers are more likely to cause epidemics. When control measures are possible epidemiologists are more interested in the effective reproduction number (R).

The R number which would apply if nobody in the population had any immunity to the disease at all, in the absence of any control measures (such as when smallpox was first introduced to Pacific islands, or the American continents) is referred to as the *basic reproduction number* or R_0 (that's a zero or nought, not a letter "O"). R_0 gives a measure of the infectiousness of the organism *per se*, which tends to be relatively fixed, as it is not affected by e.g. the uptake of vaccine or immunity from previous epidemics of the disease.

R_0 is proportionate to:

- The length of time that the case remains infectious (*duration of infectiousness*)
- The number of contacts a case has with susceptible hosts per unit time (**the contact rate**)
- The chance of transmitting the infection during an encounter with a susceptible host (*the transmission probability*).

This is plain common sense, and can be expressed mathematically as:

$$R = c\,p\,d$$

where:

c is the number of contacts per unit time,
p is the transmission probability per contact, and
d is the duration of infectiousness.

The effective reproduction number – *R*

Effective reproductive number (R) is the actual average number of secondary cases per primary case observed in a population with an infective disease. The value of R is typically smaller than the value of *basic reproductive rate* (R_0), and it reflects the impact of control measures and depletion of susceptible persons by the infection.

Examples

Early in a new infectious disease R will be close to R_0

- SARS
  - R_0 = 3.6 (95% CI 3.1–4.2) which was the same as R in early stages as this condition had no specific treatment[2]
  - R = 0.7 (95% CI: 0.7–0.8) obtained by intense control measures and allowed fairly rapid control once recognised as a highly infectious disease with respiratory transmission

- Swine influenza 2009
  - R_0 northern hemisphere summer 1.4 – 1.5 with delay strategy
  - Initial R from southern hemisphere winter 1.8 to 2.3 in community/school winter outbreaks before disease recognised and control measures emplaced[3]

The effective reproduction number will change as, for example, people become immune to the disease. During an epidemic R will typically start as >1, fall to about 1 (at which stage the incidence of the disease will remain approximately static), or fall below 1, at which point the level the epidemic will cease – at least until the proportion of the population that is susceptible increases to levels at which another epidemic may arise. This explains the regular peaks and troughs in the incidence of e.g., Parvovirus B19 infection, or of most childhood illnesses prior to the introduction of vaccination.

The effective reproduction number – R is the basic reproduction number (R_0) times the fraction of the population that is susceptible to infection (x):

$$R = R_0\,x$$

As an epidemic spreads, and people die or become immune to the disease, x decreases, and eventually becomes small enough that R drops below 1.

The control reproduction number – R_c

The control reproduction number (R_c) is the average number of secondary cases due to each case in the presence of control measures such as vaccination. The aim of control measures is to ensure that the disease is eliminated from a population, which will happen if R_c is less than 1

In the case of vaccination, the control reproduction number is given by the following equation:

$$R_c = R_0\,(1 - h\,f)$$

where

- h is the vaccine efficacy (the proportion of people vaccinated who will have complete protection), and
- f is the vaccine coverage (proportion of the population that has been vaccinated).

(It's actually usually rather more complicated, as some of the population will have natural immunity.)

So, if the goal of a vaccination programme is to eliminate a disease (or, to put it another way, to ensure that there is herd immunity), the vaccine coverage that is required is given by the following equation:

Goal: $R_c < 1$

Vaccine coverage required:

$$f > \frac{1 - (1/R_0)}{h}$$

R_0 values and vaccine coverage levels for particular infectious diseases

R_0 values, and the vaccine coverage required to prevent them are given for selected disease in the following table:[4]

R_0 values, and the vaccine coverage required to prevent them

Disease	R_0	Vaccine coverage (course completed) required for herd immunity
Diphtheria	6–7	85%
Measles	12–18	83%–94%
Mumps	4–7	75%–86%
Pertussis	12–17	92%–94%
Polio	5–7	80%–86%
Rubella	6–7	83%–94%
Smallpox	5-7	80%–85%

References

1. Figure 2: Probable cases of severe acute respiratory syndrome, by reported source of infection – Singapore, February 25–April 30, 2003. From Leo YS, Chen M, Heng BH, Lee CC, Paton N, Ang B, et al. Severe Acute Respiratory Syndrome --- Singapore, 2003. *MMWR – Morbidity & Mortality Weekly Report* 2003;52(18):405–11.

2. Wallinga J, Teunis P. Different epidemic curves for severe acute respiratory syndrome reveal similar impacts of control measures. *American Journal of Epidemiology*. 2004 Sep 15; 160(6):509–16. (Link to article – subscription may be required.)

3. Planning Assumptions for the First Wave of Pandemic A(H1N1) 2009 in Europe ECDC 29 July 2009

4. Lecture "Concepts for the prevention and control of microbial threats – 2". Center for Infectious Disease Preparedness, UC Berkeley School of Public Health.

Drug Concentration in the Blood (In-Class Activity)

Natalia Mosina
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Project Quantum Leap

Math Topic
Rational expressions, complex fractions

Purpose
Motivation

When to Introduce
Week 7–8

Activity Time Frame
Approximately 1 hour of in-class time

Objectives

The goal of this PQL project is to help students learn to recognize and appreciate math in the everyday world. In this activity students will learn what pharmacokinetics is and will look at several mathematical models that can be used to calculate the concentration of a drug in a patient's blood. While doing exercises comparing different concentrations of drugs in the blood at various times, students will apply the skills of simplifying rational expressions and complex fractions. Finally, students will see that there are different ways (algebraic and graphical) to model drug/alcohol concentration, and will learn how both ways can be used to arrive at certain conclusions.

Reflection

I recommend doing this activity during the week when complex fractions are studied. When I have used this activity with my students, I have found that if all the project requirements are clearly explained and students are guided through the in-class activity step-by-step, they have no problem answering all the questions on Handout #2. For further study, I recommend that students also complete the follow up PQL activity "More on Blood Drug/Alcohol Concentration" at home. The take-home activity helps to ensure that students have mastered the math concepts used in both activities, giving them a chance to reflect more upon the consequences of drugs and alcohol, and providing additional opportunities to see how math is used in "real world" situations.

Either student responses to Handout #2 or the work they complete on the take-home "More on Blood Drug/Alcohol Concentration" activity can be deposited into the Assessment area of the ePortfolio system. It is best to demonstrate to students how to upload their projects into the Assessment area. The lab hour can be used for this purpose. Uploading should take about 5–10 minutes, providing there are no technology glitches.

Activity Overview

In order to help students see the connection between the math they're learning in class and the power of math to solve real-life problems, particularly issues involving public health, start with a discussion of Reading #1: Everything's A Math Problem. The following procedure is recommended for this PQL activity:

1. Have students work in groups to reflect on and discuss the ways in which they use math in their everyday lives. Then distribute Reading #1: Everything's A Math Problem and Handout #1 with the questions. Have students read and discuss the reading in class.

2. Distribute Reading #2: Math of Drugs and Bodies for students to read in class.
3. Discuss the reading with students, checking that they understand pharmacokinetics, what happens with drug concentration over time, what models can be used to describe the behavior of a drug in the patient's blood, etc. Emphasize how the topic connects to MAT096.
4. Have students answer questions 1–6 in Handout #2. Give students time to think, and to work independently. Encourage students to show their computations on the board.
5. Compare students' computations to yours and discuss any errors in students' computations. Make sure students understand the source of their errors.
6. Collect students' work at the end of the activity and distribute the Answer Key (Handout #3)

At this point, the instructor can give students the take-home PQL activity, "More on Blood Drug/ Alcohol Concentration."

Materials and Resources:

- Handout #1 : Discussion Questions
- Handout #2: Drug Concentrations, Rational Expressions, and Complex Fractions
- Handout #3: Answer Key for questions in Handout #2
- Reading #1: Duval, Robert. (n.d.). Everything's a math problem. Retrieved from Article Sphere.com website: http://www.articlesphere.com/Article/Everything-s-a-Math-Problem/183538
- Reading #2: Excerpted from "Math of drugs and bodies (pharmacokinetics)." (2010, February 1). Retrieved and adapted from SquareCircleZ website: http://www.squarecirclez.com/blog/math-of-drugs-and-bodies-pharmacokinetics/4098)

Handout#1: Discussion Questions

Mosina | Elementary Algebra – Problems and Issues in Public Health (MAT096)

The following discussion questions are based on Reading #1: Everything's a math problem, by Robert Duval. (Source: Duval, Robert. (n.d.). Everything's a math problem. Retrieved from Article Spere.com website: http://www.articlesphere.com/Article/Everything-s-a-Math-Problem/183538.)

Based on the reading, answer the questions below. Make sure you have read Reading #1 before you take a few minutes to write a response to each question. We will discuss these questions in class.

1. Explain the meaning of "everything's a math problem."

2. How do you feel about learning math? Explain why you feel that way.

3. In your experience learning math, how often do you think your teachers showed you the power of math to solve real life problems? Did this change the way you felt about math?

4. Do you think a basic competency in math is essential for everyone? Explain why, or why not.

5. According to the article, why is the expression "math puzzle" preferable to "math problem?" Would it make you see math problems differently if they were called math puzzles? Explain why, or why not.

6. This project is about drug concentration in the blood. Before you look at Reading #2, use your intuition, and your own current knowledge and experience to answer the following question:

   When you take a drug (for example, a cold medication), what happens to the concentration of this drug in your blood over time? Write your answer below.

Handout#2: Drug Concentrations, Rational Expressions, and Complex Fractions

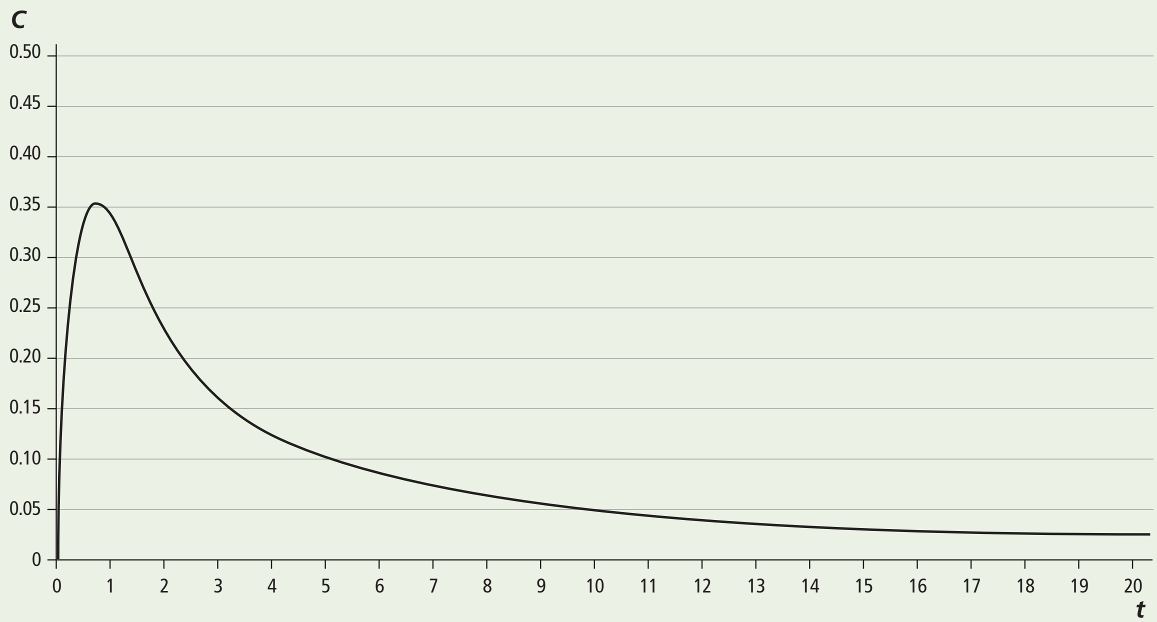
Mosina | Elementary Algebra – Problems and Issues in Public Health (MAT096)

In Reading #2, we saw one of the possible models for drug concentration at time *t*.

Sometimes, the concentration of a certain drug in a patient's bloodstream can be given as a rational expression, such as,

Equation (2): $C(t) = \dfrac{t}{2t^2 + 1}$ (measured in grams of drug /100ml blood, or %)

Figure 2: Drug concentration after *t* hours



The graph in Figure 2 was created using Maple software. Note: This shape is similar to the one you saw in Figure 1 on Reading #2.

Now, answer the following questions:

1. What is the concentration of the drug at time $t = 0$ hours in the model described by Equation (2)?

2. What is the concentration of the drug at time $t = ½$ hour in the model described by Equation (2)?

3. Look at Figure 2 and estimate the time t (after injection) at which the concentration is highest.

4. What happens to the concentration of this drug over time? Find explanations in Reading#2.

   Critical Thinking: Do both models, the graphical and the algebraic representations of the drug concentration in Figure 2, confirm your intuition and the inference you drew from the text?

   In class, discuss whether each model confirms your intuition that $C(t)$ will decline as t increases.

5. Let $t_1 = 1$ and $t_2 = 3/2$ hours. Find the ratio $\dfrac{C(t_1)}{C(t_2)}$

6. Let $t_1 = x/2$ and $t_2 = x$ hours. How many times greater is $C(t_1)$ than $C(t_2)$, assuming that $x > 1$? [In other words, find the ratio $\dfrac{C(t_1)}{C(t_2)}$.] Simplify your rational expression.

Handout#3: Solutions/Answers to Questions in Handout #2

Mosina | Elementary Algebra – Problems and Issues in Public Health (MAT096)

1. It is given that $t = 0$ hours. Plug it in Equation (2) and find what $C(0)$ is. In this way, we find the concentration of the drug at time $t = 0$ in the model described by Equation (2):

$$C(0) = \frac{0}{2(0^2) + 1} = \frac{0}{1} = 0\%$$

2. Now, $t = \frac{1}{2}$. Plug it in Equation (2):

$$C\left(\frac{1}{2}\right) = \frac{\frac{1}{2}}{2 \times \frac{1}{2} \times \frac{1}{2} + 1} = \frac{\frac{1}{2}}{\frac{1}{2} + 1} = \frac{\frac{1}{2}}{\frac{3}{2}} = \frac{1}{2} \times \frac{3}{2} \approx 0.33\%$$

Look at Figure 2 to see that the graph supports the answer you calculated algebraically.

3. The graph in Figure 2 shows that the concentration of the drug is the highest at the time $t \approx 0.8$ hours (after injection).

4. The concentration of a drug in the blood will level off as time goes by. In other words, *C(t)* will eventually decrease. Indeed, as stated in Reading #2, "As time goes on, the drug concentration gets less and less and falls below a certain effective amount. Then it's time to take some more pills." The graphical representation of the drug concentration in Figure 2 confirms our intuition and the inference we drew from the Readings. Indeed, Figure 2 shows that *C(t)* gradually decreases as time goes by. If you think about it, the algebraic model tells the same story: after some time, the bigger the value of *t*, the smaller the value of the rational expression for *C(t)*. Discuss this in class with your instructor.

5. If $t = 1$ hour, then

$$C(1) = \frac{1}{2(1^2) + 1} = \frac{1}{2 + 1} = \frac{1}{3}\%$$

If $t = \frac{3}{2}$ hours, then

$$C\left(\frac{3}{2}\right) = \frac{\frac{3}{2}}{2 \times \frac{3}{2} \times \frac{3}{2} + 1} = \frac{\frac{3}{2}}{\frac{9}{2} + 1} = \frac{\frac{3}{2}}{\frac{11}{2}} = \frac{3}{2} \times \frac{2}{11} = \frac{3}{11}\% \quad \textbf{\textit{and}} \quad \frac{C(1)}{C\left(\frac{1}{3}\right)} = \frac{\frac{1}{3}}{\frac{11}{9}} = \frac{11}{9}$$

6.

$$C\left(\frac{x}{2}\right) = \frac{\frac{x}{2}}{2 \times \frac{x}{2} \times \frac{x}{2} + 1} = \frac{\frac{x}{2}}{\frac{x^2}{2} + 1} = \frac{\frac{x}{2}}{\frac{x^2+2}{2}} = \frac{x}{2} \times \frac{2}{x^2+2} = \frac{x}{x^2+2}, \; C(x) = \frac{x}{2x^2+2}$$

$$\frac{C(t_1)}{C(t_2)} = \frac{\frac{x}{x^2+2}}{\frac{x}{2x^2+1}} = \frac{x}{x^2+2} \times \frac{2x^2+1}{x} = \frac{2x^2+1}{x^2+2}$$

Reading #1: Everything's A Math Problem

Mosina | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Source: Duval, Robert. (n.d.). Everything's a math problem. Retrieved from Article Sphere.com website: http://www.articlesphere.com/Article/Everything-s-a-Math-Problem/183538

There are probably an endless number of math problems. When you are studying math in elementary or high school, you have no idea of the huge world of math that exists at the college and post-college levels. Additionally, when you're studying elementary-level math, it's sometimes hard to make the connection between seemingly-insignificant math problems and the ultimate power that math has to solve problems in real life.

Think of medicine, for example. Students who started out the same as you and I, learning about square roots and fractions in elementary and junior high schools, have ended up using math to solve major health problems such as polio and tetanus. By turning health problems into math problems, collecting data and turning it into numbers, public health workers and epidemiologists figured out what was causing these diseases. Then, they solved the math problems and figured out how to get rid of the diseases. Without the beginning elements of addition, subtraction, algebra, geometry, calculus, and statistics, this could not have happened. Mastery of finding solutions to math problems allowed scientists to solve health problems and relieve human suffering. They can then analyze the effect of various solutions to those problems with controlled trials. All of this would be impossible without math.

At the college level, students usually see those seemingly meaningless math problems, like how much bread Joe can carry if his bicycle has a basket that is 1 foot by 1 foot, turn into real-life issues. If you study social science, you'll do research using math. You'll probably use software such as SPSS that makes the quantitative part of solving math problems easy. However, the student has to understand what the data is telling her/him and know how to input it into the program in order for it to work.

Improving your house is also another area where you will encounter math problems. If you want to repaint one or several walls, you have to figure out many issues. This is not a really advanced math problem, but it does show how math applies to everyday life. It's for this reason that everyone in the United States is required to achieve at least a basic competency in math. People who study education are aware that all aspects of our daily lives involve math in many ways.

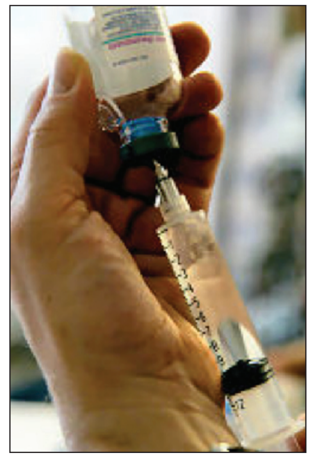
When we think of solving math problems, the idea makes many of us cringe. Perhaps this is in part due to the misnomer of the word problems. It would be better if we called them "math puzzles" instead. Doesn't that make it sound more enticing? Math puzzles would be something fun, playful, or exciting. While calling them math problems makes them sound bad, calling them math puzzles makes you feel that you're accomplishing something if you put the puzzle together. That's really more accurate as to what math is all about anyway.

In math, we are given a question, such as how much, when, how long, to what degree, etc. That is the mystery part and provides the frame for the puzzle. In real life we always have some elements of the puzzle, like the speed of a vehicle and how far the vehicle is going to go. These are the puzzle pieces. Then we take the information and the framework to put the pieces together and put it into the frame. This is what math problems really are.

Reading #2: Math of Drugs and Bodies (Pharmacokinetics)

Mosina | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Source: Excerpted from "Math of drugs and bodies (pharmacokinetics)." (2010, February 1). Retrieved and adapted from SquareCircleZ website: http://www.squarecirclez.com/blog/math-of-drugs-and-bodies-pharmacokinetics/4098)



Pharmacokinetics is a branch of pharmacology that studies processes by which substances (like food and drugs [alcohol, in particular] are ingested into the body (via mouth or needles) and processed. We will concentrate on drugs.

The process of pharmacokinetics has 5 steps:

- **Liberation** – the drug is released from the formulation
- **Absorption** – the drug enters the body
- **Distribution** – the drug is dispersed throughout the body
- **Metabolism** – the drug is broken down by the body
- **Excretion** – the drug is eliminated from the body

Of course, each drug needs to act on the body in a different way. Some drugs need to be absorbed quickly (like nitroglycerin, if we are having a heart attack) and preferably eliminated quickly (otherwise toxins build up in the blood). However, slow absorption is necessary for other drugs so that we derive maximum benefit and don't lose a lot of the drug through excretion.

So when your doctor prescribes (say) "take 2 tablets every meal time", this is based on the desirable levels of drug concentration and known levels of distribution, metabolism and excretion in the body.

What's the math?

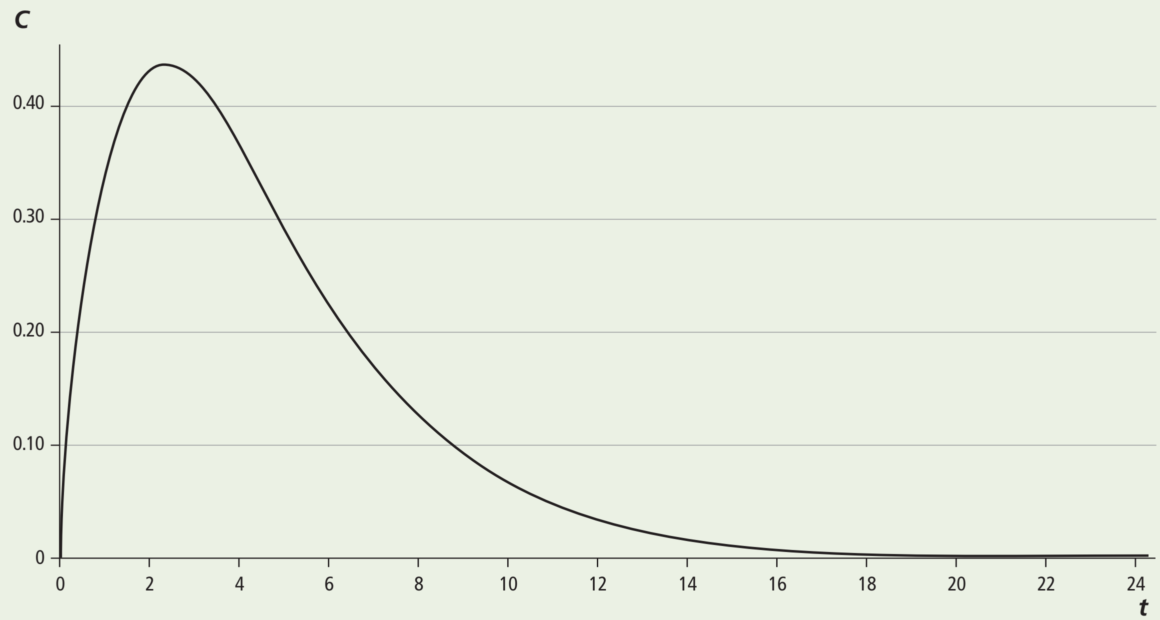
When a nurse first administers a drug, the concentration of the drug in the blood stream is zero. As the drug moves around the body and is metabolized, the concentration of the drug increases. There comes a point when the concentration no longer increases and begins to decrease. This is the period when the drug is fully distributed and metabolism is taking place. As time goes on, the drug concentration decreases more and more, until it falls below a certain effective level. At that point, it's time to take some more pills.

It is possible to model such a situation. One of the possible models for drug concentration at time t is, for example,

Equation (1): $C(t) = 533.3(e^{-0.4t} - e^{-0.5t})$, where $C(t)$ = concentration of the drug at time t.

NOTE: e =2.718281828459… is an irrational number

Figure 1



We can use one of the computer algebra systems to generate a visual aid (graph) representing the drug concentration in a given model in Equation (1) above.

For the sake of simplicity, let us avoid units of measurement for now.

We can see in the graph the portion where the concentration increases (up to around $t = 3$) and levels off. The concentration then decreases to almost zero at $t = 24$.

Indeed, pharmacokinetics is yet another interesting "real life" application of math.

More on Blood Drug/Alcohol Concentration (Take-Home Activity)

Natalia Mosina
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

PREREQUISITE:
Drug Concentration in the Blood (In-Class Activity)

Math Topic
Rational expressions, complex fractions, graphs, pie charts, and percentages

Purpose
Motivation, application of math skills working with fractions and rational expressions

When to Introduce
Weeks 7–8

Activity Time Frame
One week at home

Objectives

The goal of this PQL project is to follow up on the in-class PQL activity,“ Drug Concentration in the Blood.” In this take-home activity, students will work with a mathematical model involving rational expressions that can be used to calculate the concentration of alcohol in a patient’s blood. Students will also learn what factors affect alcohol absorption and elimination as well as the consequences of alcohol abuse and alcoholism. They will also practice drawing conclusions based on given graphs and pie charts.

Reflection

I recommend assigning this activity during the week when complex fractions are explained, after the in-class PQL activity “Drug Concentration in the Blood” is competed. It is advisable to give students one week to complete this take-home project. When I gave this activity to my students, I found that if I explained all the project requirements clearly, students had no problem completing it at home. The completed work can be uploaded into the Assessment area of the ePortfolio system. Uploading should take about 5-10 minutes, provided there are no technology glitches.

Activity Overview

The activity consists of two parts: Part I provides an immediate follow up to the in-class PQL Activity, “Drug Concentration in the Blood.” Students work with a given drug concentration model, performing computations with a given rational expression using the skills they developed while studying complex fractions. In Part II, students read about the factors affecting blood alcohol concentration (BAC), and learn about the cost of alcohol abuse in our society. After reading these materials, students respond to questions.

Make sure that students have completed and understood the in-class PQL activity “Drug Concentration in the Blood,” which is a prerequisite for the current activity.

The following procedure is recommended for this take-home PQL project: After you distribute the handout, take a few minutes to discuss the introduction and observation section of the Handout and how these relate to the “Drug Concentration in the Blood” PQL activity. Then, distribute Readings Passages A and B.

Working independently at home, students answer all the questions in the Handout.

Materials and Resources

- Handout
- Reading: Passage A and Passage B from National Institutes of Health/National Institute on Alcohol Abuse and Alcoholism. (n.d.). Understanding alcohol. Retrieved from http://science-education.nih.gov/supplements/nih3/alcohol/guide/info-alcohol.htm#BAC
- Also see: Reading #2 from the prerequisite PQL activity, "Drug Concentration in the Blood." Reading excerpted from "Math of drugs and bodies (pharmacokinetics)." Retrieved and adapted from the SquareCircleZ.com website: http://www.squarecirclez.com/blog/math-of-drugs-and-bodies-pharmacokinetics/4098)

Handout: Project Tasks

Mosina | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Introduction and Observation:
Refer to Reading #2 and Handout #2 from the in-class PQL activity entitled "Drug Concentration in the Blood."

Given Model (X): The concentration of alcohol in a person's bloodstream is given as a rational expression

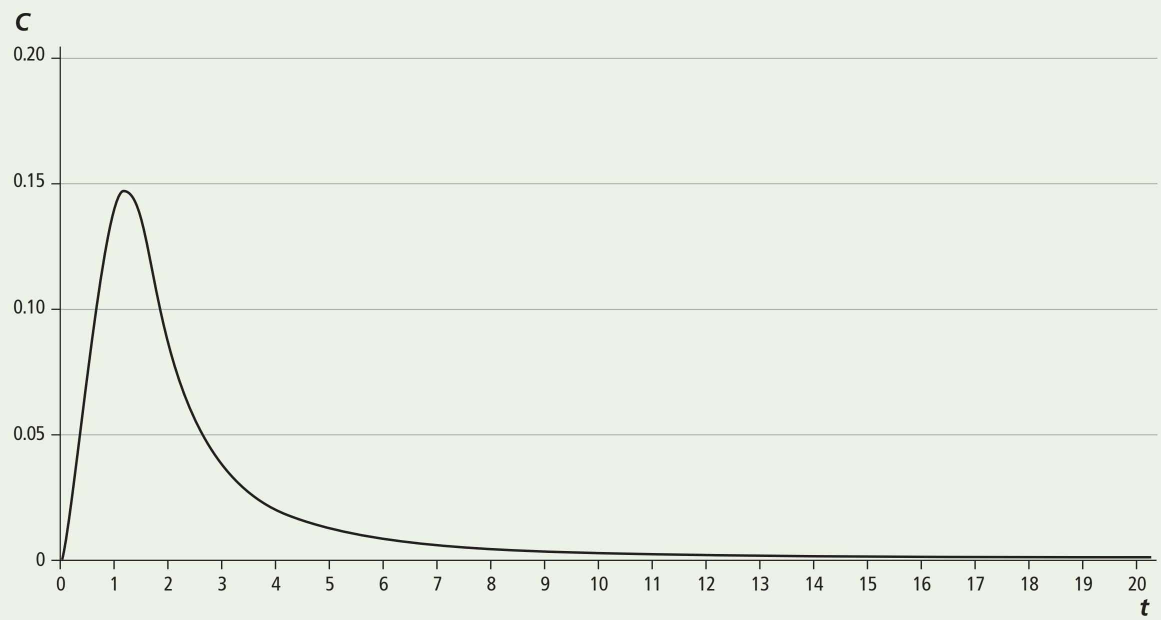
$$C(t) = \frac{t^2 + t}{(4t^4 + 10)(t + 1)}$$

where $C(t)$ = concentration of the drug/alcohol (grams of alcohol/100ml blood or %) at time t (hours).

The following graph of $C(t)$ will help you visualize the model:

We can use the Maple computer algebra system to generate a graph representing the drug/alcohol concentration in a given Model (X).

Figure A: Graph of C(t) – Blood Alcohol Concentration (BAC) after t hours



Observe the typical shape of the graph. Compare it with Figure 1, in Reading #2 from the in-class PQL activity you completed, "Drug Concentration in the Blood."

More on Blood Drug/Alcohol Concentration

Task 1

Use what you have learned from your work on the "Drug Concentration in the Blood" activity, and what you have read to answer the questions below:

1. Simplify the rational expression (X) that models the alcohol concentration in a person's bloodstream after t hours:

   $$C(t) = \frac{t^2 + t}{(4t^4 + 10)(t + 1)}$$

   Hint: Factor the numerator and reduce the rational expression.

2. What is the concentration of the drug at time $t = 0$ in the given model (X)? Does your answer confirm what you see in the graph of $C(t)$?

3. What is the concentration of the drug at time $t = \frac{1}{2}$ hour in the model described by Equation (X)?

4. Look at Figure A and estimate the time t (after drinking) at which the blood alcohol concentration (BAC) is the highest.

5. Let $t_1 = x$ hours and $t_2 = 2x$ hours. How many times greater is $C(t_1)$ than $C(t_2)$, assuming that $x > 2$? (In other words, find the ratio $\frac{C(t_1)}{C(t_2)}$.) Simplify your answer.

Task 2

Read the following two excerpts from the NIH/NIAAA website, (retrieved February 25, 2011 from http://science-education.nih.gov/supplements/nih3/alcohol/guide/info-alcohol.htm#BAC, National Institute of Health.) Answer the questions for each.

After you have read Reading Passage A, answer the following questions in paragraph form:

1. Think about the factors that influence how quickly alcohol is absorbed into the blood. Explain the role of one factor of your choice.

2. Look at Figure B in Reading Passage A :
   - What does Figure B show? How does it support the statement that "Absorption of alcohol is faster when the stomach is empty"?
   - From Figure B, approximate BAC after a person drank alcohol following an overnight fast and immediately after breakfast at time $t = 1$ hour. Which one is greater?

3. Explain how gender influences BAC.

After you have read Reading Passage B, answer the following questions in paragraph form:

1. How much did alcohol abuse and alcoholism cost our society in 1998?

2. In 1998, what percent of the total cost of alcohol abuse was borne by private insurance companies? Calculate the exact dollar amount. Use the text and the pie chart in Figure C in Reading Passage B to answer this question.

Reading Passage A: Factors affecting alcohol absorption and elimination

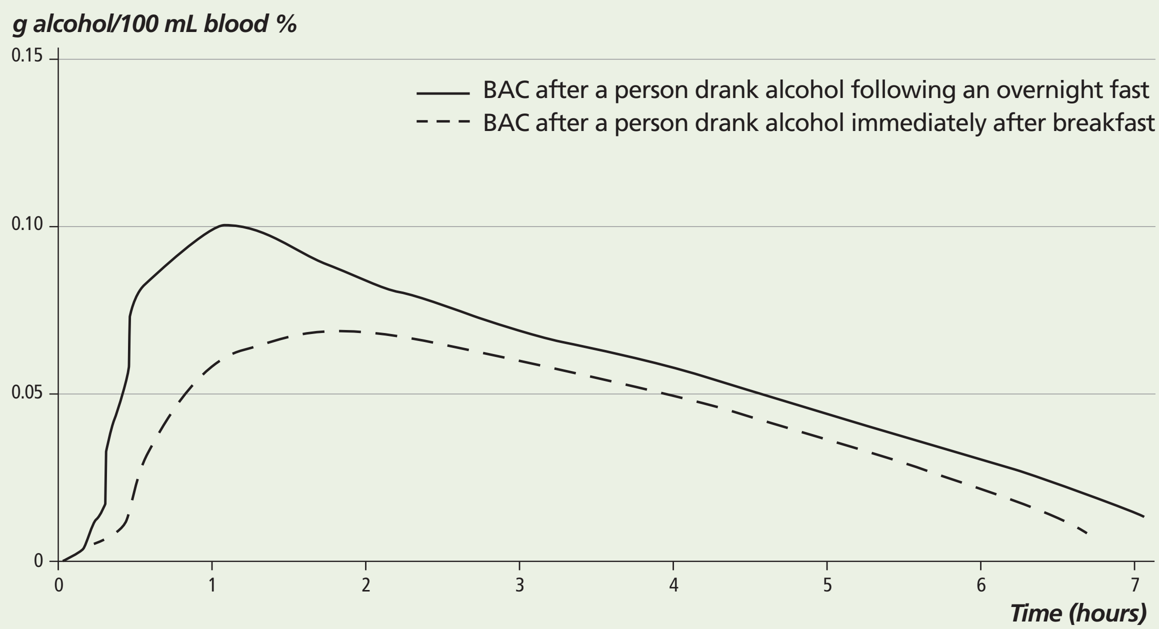
Mosina | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Source: National Institutes of Health/National Institute on Alcohol Abuse and Alcoholism. (n.d.). Understanding alcohol. Retrieved from http://science-education.nih.gov/supplements/nih3/alcohol/guide/info-alcohol.htm#BAC

Alcohol impairs the functions of the mind and body. These impairments depend on the amount of alcohol in the blood, as measured by the blood alcohol concentration. Factors that influence the BAC include the number of drinks and the time period over which they are consumed, as well as the drinker's gender and body weight. The body breaks down, or metabolizes, alcohol at a relatively constant rate, regardless of the rate at which it is consumed. Humans vary widely in their ability to absorb and eliminate alcohol. Here we describe some of the important factors that influence how quickly alcohol is absorbed into the blood.

Food. Absorption of alcohol is faster when the stomach is empty; the empty stomach allows rapid passage of the alcohol into the small intestine, where absorption is most efficient. (see Figure B). The rate of alcohol absorption depends not only on the presence or absence of food, but also on the type of food present. Eating fatty foods will allow alcohol absorption to take place over a longer time.

Figure B. The effect of food on blood alcohol concentration



Body weight and build. Greater body weight provides a greater volume in which alcohol can be distributed. This means a larger person will be less affected by a given amount of alcohol than a smaller person would be. Alcohol is more soluble in water than in fat. This means that tissues rich in water, like muscle, take up more alcohol than do tissues rich in fat. A leaner person with a greater muscle mass (and less fat) provides a larger volume for alcohol to be distributed in compared with a person who weighs the same but has a higher percentage of body fat.

In summary, if you compare two people of equal size but who differ in amount of body fat, the effects of alcohol will be different in them.

Gender. Females, on average, have a smaller body mass and a higher proportion of body fat than do males. These characteristics mean that, on average, females have a lower proportion of total body water in which to distribute alcohol. Females also may have a lower activity of the alcohol-metabolizing enzyme **alcohol dehydrogenase (ADH)** in the stomach; therefore, more of the ingested alcohol reaches the blood. These factors mean that females generally exhibit higher BACs than do males after consuming the same amount of alcohol, and are more vulnerable to alcohol's effects.

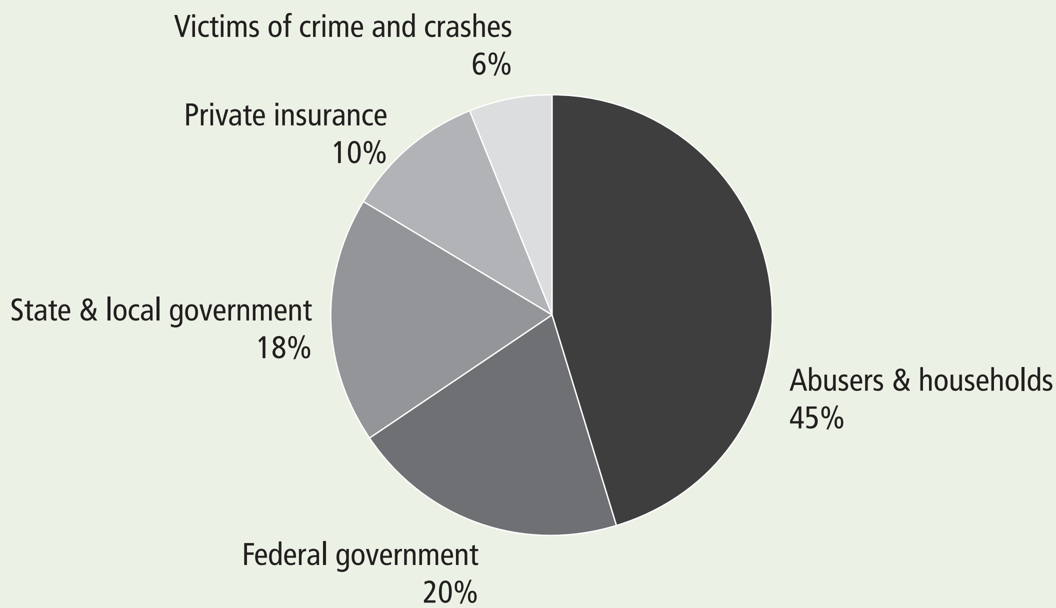
Reading Passage B: Consequences of Alcohol Abuse and Alcoholism: The costs to society

Mosina | Elementary Algebra – Problems and Issues in Public Health (MAT096)

Source: National Institutes of Health/National Institute on Alcohol Abuse and Alcoholism. (n.d.). Understanding alcohol. Retrieved from http://science-education.nih.gov/supplements/nih3/alcohol/guide/info-alcohol.htm#BAC

Alcohol abuse and alcoholism have a large economic impact on our society. In 1998, alcohol abuse and alcoholism cost an estimated $185 billion in lost productivity, illness, premature death, and healthcare expenditures. For 1995, these costs were estimated to be over $166 billion, and in 1992, they were $148 billion. A large portion of these costs is borne, in various ways, by non-abusers (see Figure C). While 45 percent of the costs of alcohol abuse fall on the abusers themselves and their families, 38 percent falls on government (in the form of lost or reduced tax revenue). Additional costs to non-abusers include, but are not limited to, the economic costs of the criminal justice system and higher insurance premiums, as well as the social costs of alcohol-related crimes and trauma.

Figure C. Distribution of the cost of alcohol abuse in the United States in 1998



3

COLLEGE ALGEBRA – TRIGONOMETRY

Business and Finance (MAT115)

Project Quantum Leap

This course will start with a review of basic algebra (factoring, solving linear equations, and equalities, etc.) and proceed to a study of polynomial, exponential, logarithmic, and trigonometric functions. These functions will be used in applications involving simple mathematical modeling where students will engage in inquiry activities aimed at improving critical thinking skills.

Modeling Unemployment Rates Data

Denise A. Carter
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

To demonstrate to students that math is a part of their daily lives and that the concepts learned in class are relevant to the real world. This lesson will show that actual data taken from January to September 2008 unemployment rates are approximately linear. Linear functions are encountered from Lesson 2 to Lesson 13 in the syllabus of College Algebra and Trigonometry (MAT115). Through this activity, students are expected to achieve the following:

- To understand the concept of a function and its role in mathematical modeling of real-life problems
- To know how to recognize a linear function
- To be able to graph a linear function
- To be able to write the equation of a linear function
- To solve textbook applications of linear functions
- To solve systems of linear equations in two variables by using the graphical, elimination, and substitution methods
- To learn the MAPLE commands for this activity
- To read articles about unemployment rates

Math Topics
Graphing linear equations, equation of a line, applications of linear functions

Purpose
Synthesis

Comments
Based on unemployment rates data and news coverage in the *Washington Post* and ABC News

When to Introduce
Week 10 (after introducing measurements and plotting graphs)

Duration
Week 3

Activity Time Frame
From a week to a week-and-a-half

Reflection

I am using economic current events that are pertinent in students' lives to show the relevance and importance of math. It is anticipated that students will become more aware about their economic predicament and take a more active and aggressive role in their daily lives. It is also expected that they will be able to translate the concepts to similar situations.

The students at first were somewhat intimidated by the project because it was the first major project and they did not know what to expect. But they later realized that all the preparation they received from classwork, homework, and MAPLE labs was pertinent to the assignment.From the students' comments concerning the project, they seemed to have gained more respect for math because they were able to see the learned concepts used in real situations.

Because this project was meant for ePortfolio, I expected students to demonstrate their abilities to read, analyze, think critically, and communicate effectively. I have learned from my experience that this seemingly daunting task makes many students anxious. In the future, I will introduce reading material earlier, and prepare mini practice projects to make a smoother transition into the first major project.

Activity Overview

This project should be introduced after Lesson 13 and after the MAPLE commands are learned. This will be about three-and-a-half weeks into a twelve-week semester. The students are given a week to a week-and-a-half to complete the project.

1. After Lesson 13, distribute "Modeling Unemployment Rates Data" Project Handout. Direct students to (i) read the *Washington Post* and ABC News articles, and (ii) listen to Dan Arnell's report on the ABC News website.
2. Ask students to follow the instructions in the handout to (i) write a brief review of the *Washington Post* article and (ii) indicate what the hardest hit industries were, based on the ABC News report.
3. In a computer lab, ask students to use MAPLE to analyze the unemployment rates data for the months January through September 2008 provided in the handout. The instructor should encourage collaborative learning, and offer necessary assistance.
4. As homework, ask students to verify the numerical results, and write a reflection based on their quantitative analysis.
5. Collect the complete project, and ask students to deposit the electronic version on ePortfolio.

Materials and Resources

Background information on the unemployment situation is given in the following articles:

- Handout
- Reading #1: Irwin, N., & Rosenwald, M.S. (2008, October 23). Job losses accelerate, signaling deeper distress. *Washington Post.* Retrieved January 30, 2009, from http://www.washingtonpost.com/wp-dyn/content/article/2008/10/22/AR2008102203709_pf.html
- Reading #2: Unemployment at 5 year high as U.S. loses 84,000 jobs. *ABCNews.com* Retrieved January 29, 2009, from http://abcnews.go.com/Business/Economy/Story?id=5733848&page=1 (Listen to Dan Arnell's report on 84,000 jobs slashed in August 2008.)
- Unemployment data percentage rates can be obtained from the *U.S. Misery Index* (2008, November 9). Retrieved January 29, 2009, from http://www.miseryindex.us.
- PowerPoint presentations were used when teaching functions in general, linear functions, and solving systems of linear functions. Handouts were also used to reinforce topics. Please contact Dr. Denise A. Carter for these materials.

Handout: Modeling Unemployment Rates Data

Carter | Algebra and Trigonometry – Business and Finance (MAT115)

Due: ________________
Late papers will lose 10 points.

Objective

To enhance the understanding of linear functions through the use of MAPLE and current newspaper articles on unemployment in the United States.

Directions

Read the following articles: (i) Irwin, N., & Rosenwald, M.S. (2008, October 23). *Job losses accelerate, signaling deeper distress* attached to this handout and (ii) the ABC News *Unemployment at 5-year high as U.S. loses 84,000 jobs.* Listen to Dan Arnell's report on 84,000 jobs slashed at http://abcnews.go.com/Business/Economy/Story?id=5733848&page=1.

Use MAPLE to solve the following

1. Write a brief review of the Irwin & Rosenwald article. [25 points]
2. What industries does the ABC news article state were hit the hardest this time around? [15 points]
3. The data in the table below gives the unemployment rates for the months January through September 2008 (obtained from the U.S. Misery Index website: *http://www.miseryindex.us*). [January = 1, February = 2, etc.]

Month	Unemployment Percentage Rate
1	4.9
2	4.8
3	5.1
4	5.0
5	5.5
6	5.5
7	5.7
8	6.1
9	6.1

   Make a scatter plot of the data. [20 points]

4. Find and graph the regression line that models the data above. Interpret the slope with respect to the unemployment percentage rates. [20 points]
5. Assuming that this trend continues, use the model found in Question 3:
   a. To predict the unemployment rate in July 2009. [8 points]

   b. To find when the unemployment rate will be 10%. [12 points]

6. Based on your analysis, write a reflection essay. Consider the following guiding questions:
   a. If the unemployment situation continues, what will the unemployment rate be at the time you graduate from college?
   b. What do you think the government should do to stop the job loss trend?
   c. How do you remain competitive in this tough job market?

Reading #1: Job Losses Accelerate

Carter | Algebra and Trigonometry – Business and Finance (MAT115)

Source: Irwin, N., & Rosenwald, M.S. (2008, October 23). Job losses accelerate, signaling deeper distress. Retrieved January 30, 2009, from http://www.washingtonpost.com/wp-dyn/content/article/2008/10/22/AR2008102203709_pf.html

Employers are moving to aggressively cut jobs and reduce costs in the face of the nation's economic crisis, preparing for what many fear will be a long and painful recession.

The labor market has been weak all year, with a slow drip of workers losing their jobs each month. But the deterioration of the job market is now emerging as a driver of economic distress, according to a wide range of data and anecdotal reports from corporate America.

In September, there were more mass layoffs – instances in which employers slashed 50 or more jobs at one time – than in any month since September 2001, the Labor Department said yesterday. And nearly half a million Americans have filed new claims for unemployment benefits in each of the past four weeks, the highest rate of such claims since just after the terrorist attacks seven years ago.

Anecdotal reports suggest that the hemorrhaging in the job market has only begun. Companies that announced plans this week to cut jobs include Internet company Yahoo (1,500 positions), pharmaceutical company Merck (7,200), National City bank (4,000) and Comcast, the cable company (300).

The weakening employment outlook is part of the reason that investors have become more fearful of a deep, prolonged recession – fears that led to yet another miserable day on Wall Street yesterday, with the Dow Jones industrial average down 514 points, or 5.7 percent.

"The customers I've spoken to are all living under a sense of fear," said Paul Villella, chief executive of HireStrategy, a Reston company that matches employers and workers. "They have very limited visibility into the future and have a great degree of uncertainty, so they just want to sit steady and be conservative in hiring."

Villella and others who work with employers said that for many companies, the pullback in hiring is not a direct result of tightening credit. Rather, firms simply don't know whether their own customers will be affected by the financial crisis; as a result, they want to hold their breath and delay hiring decisions until they have a better sense of the future.

The nation has shed jobs every month this year, but at a slower overall pace than in past economic downturns. The slide accelerated in late summer, with declines similar to those in past recessions. Last month, employers shed 159,000 jobs, the most this year and more than the average number of monthly job losses in the terrible labor markets of 2001 and 2002.

More obscure indicators monitored by economists at the Federal Reserve and in the private sector also show an inflection point in late summer. For example, employers had 214,000 fewer job openings in August than in July, according to a Labor Department report. Over the past year, the number of openings dropped by a more modest average of 74,000 per month.

Indeed, many companies are imposing hiring freezes. Such moves don't often get the kind of headlines that layoffs do, but because they shrink the number of places people can turn to for jobs, they still hurt the economy.

VMware, a Palo Alto, Calif., software company, is one firm that has curbed hiring. Earlier this week, after reporting third-quarter earnings that beat Wall Street's expectations, VMware told analysts on a conference call that despite a 32 percent jump in revenue, a "hiring pause" had been imposed for all jobs except critical ones.

"We are just being conservative," VMware spokeswoman Mary Ann Gallo said yesterday.

The nation's unemployment rate was 6.1 percent last month, not astronomical by historical standards. But the rate was up from 5 percent in April, and many forecasters now expect it to hit 7 percent or more by the end of this downturn.

The construction and manufacturing sectors have been losing jobs for more than a year. But lately, job losses have begun or accelerated in a wide range of other fields. Retailers, stung by less consumer spending, cut 87,000 jobs in the three months ended in September. Employment services shed 100,000 positions in that span, reflecting the fact that companies are slashing temporary jobs. The leisure and hospitality industry cut 51,000 jobs, as people had less money to stay in hotels and eat in restaurants.

In the greater Los Angeles area, Manpower, one of the nation's largest temp agencies, has noticed a steady increase in job seekers since early September. Paul Holley, a spokesman for the company, said there are more applicants for fewer openings and better-qualified candidates seeking work.

What's particularly noteworthy, Holley said, is what's happening in Phoenix. Job applications have held steady, but since September more applicants have had backgrounds in general labor and warehouse distribution. That's unusual because warehouse and logistics jobs usually hold steady in the fall to support retailing for holiday shopping.

Randstad USA, another large temp agency, reports that job applications are up in the Tucson area and that the firm is even getting inquires from people who still have jobs. "In general, a lot of people seem to be insecure about their current jobs even if they are still employed," said Emily Cline, Randstad's area vice president for Tucson.

As reports of layoffs continue to pile up around the country, executives at Randstad said they have noticed a shift in psychology among job seekers.

"Employees are much more willing to work extra hours and to take on additional duties to enhance job security and improve their employability," said Eric Buntin, managing director for marketing and operations at Randstad. "In a changing market, they know that's a valuable resource."

They are also willing to make less money, even as the cost of living goes up. Cline said some call center jobs that were paying $9 an hour in the Tucson area last year are now paying $8.50. "Their option becomes to take the job or not have the job," she said.

With workers losing their leverage to negotiate raises, there could be greater downward pressure on wages, which in turn could drive down overall economic growth. Workers are already having a hard time getting raises; inflation-adjusted pay for non-managerial workers fell 1.9 percent in the year ended in September, according to the Labor Department.

Staff writer Michael A. Fletcher in Cleveland contributed to this report.

Reading #2: Unemployment at 5-Year High

Carter | Algebra and Trigonometry – Business and Finance (MAT115)

Source: Irwin, N., & Rosenwald, M.S. (2008, October 23). Job losses accelerate, signaling deeper distress. Retrieved January 30, 2009, from http://www.washingtonpost.com/wp-dyn/content/article/2008/10/22/AR2008102203709_pf.html

Unemployment at 5-Year High as U.S. Loses 84,000 Jobs

The Job Losses Were Higher Than Economists Expected
Sept. 5, 2008

WASHINGTON (AP) -- The U.S.'s unemployment rate zoomed to a five-year high of 6.1 percent in August as employers slashed 84,000 jobs, dramatic proof of the mounting damage a deeply troubled economy is inflicting on workers and businesses alike.

The Labor Department's report, released Friday, showed the increasing toll the housing, credit and financial crises are taking on the economy.

How is the Economy Treating You? Tell ABC News

The report was sure to rattle Wall Street again. All the major stock indexes tumbled into bear territory Thursday as investors lost hope of a late-year recovery. With the employment situation deteriorating, there's growing worry that consumers will recoil, throwing the economy into a tailspin later this year or early next year.

The jobless rate jumped to 6.1 percent in August, from 5.7 percent in July. And, employers cut payrolls for the eighth month in a row. Job losses in June and July turned out to be much deeper. The economy lost a whopping 100,000 jobs in June and another 60,000 in July, according to revised figures. Previously, the government reported job losses at 51,000 in each of those months.

The latest snapshot was worse than economists were forecasting. They were predicting payrolls would drop by around 75,000 in August and the jobless rate to tick up a notch, to 5.8 percent. The grim news comes as the race for the White House kicks into high gear. The economy's troubles are Americans' top worry.

Wachovia Corp., Ford Motor Co., Tyson Foods Inc. and Alcoa Inc. were among the companies announcing job cuts in August. GMAC Financial Services this week said it would lay off 5,000 workers.

Job losses in August were widespread. Factories cut 61,000 jobs, construction firms eliminated 8,000 jobs, retailers axed 20,000 slots, professional and business services slashed 53,000 positions and leisure and hospitality got rid of 4,000. Those losses swamped employment gains in the government, education and health.

Job losses at all private employers -- not including government -- came to 101,000 in August.

The government said workers age 25 and older accounted for all the increase in unemployment in August.

Workers saw wage gains in August, however.

Average hourly earning rose to $18.14 in August, a 0.4 percent increase from July. Economists were forecasting a 0.3 percent gain. Over the past year, wages have grown 3.6 percent, but paychecks aren't stretching as far because of high food and energy prices.

Caught between dueling concerns of slow growth and inflation, the Fed is expected to leave a key interest rate alone at 2 percent when it meets next on Sept. 16 and probably through the rest of this year. Concerned about inflation, the Fed at its last two meetings didn't budge the rate. Before that, though, the Fed had aggressively cut rates to shore up the economy.

With the Fed on the sidelines, Democratic presidential nominee Barack Obama has called for a second round of government stimulus, while his Republican rival John McCain has favored free-trade and other business measures to spur the economy.

Car Buyers in Asia

Gordon Crandall
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

Students will read an article that describes in "grass-roots" terms the arrival of new car dealers in rural China and the consequences of vehicle ownership where scant years before, the bicycle provided the sole means of local transportation. Apart from sociological "color," data is given on the explosive growth of vehicle sales in China and in India in the past several years, along with the (slight) decline in vehicle sales in the United States. Students will model this data using exponential, quadratic, and linear models, and they will make predictions on sales volume in future years. Coming later in the semester – at the point of introduction of exponential functions – the assignment reviews linear and quadratic functions, and serves as a capstone activity on the types of growth over time featured in the course.

Math Topics
Linear, quadratic, exponential modeling

Purpose
Review, synthesis

Comments
Based on *New York Times* article describing bittersweet arrival of car dealerships in rural China

When to Introduce
Week 10

Activity Time Frame
Two weeks

Reflection

Discussion of the dynamic surge in Chinese and Indian car sales could lead naturally to cautionary tales of increased competition for finite petro-resources and increasing emissions of greenhouse gases. With prior exposure to curve fitting/modeling, students found this activity engaging. Making the graphs by hand or with Excel is visually appealing and students enjoyed creating the final product. These calculations were more natural "live" versions of the drier Educo textbook problems. However, quantitative issues are not really the main thrust of this article, although it does offer eye-opening data on the dynamic growth of automobile ownership in Asia. Instructors selecting this activity should not deprive themselves of class discussion on the impact of vehicle ownership on insulated traditional cultures. The article evokes powerfully the warm spring winds of entrepreneurial capitalism, followed – ironically – by the destructive 2008 summer earthquake in Hunan and the crash of world markets in the early fall of 2008.

Activity Overview

Week 10 (Period 1):	Activity handout and "cultural" discussion (30 minutes)
Week 10 (Period 2):	Review data entry and regression modeling features for TI-83 or Excel (40 minutes)
Week 11 (Period 1):	Hints and straggler management (20 minutes)
Week 11 (Period 2):	Wrap-up (15 minutes)

Materials and Resources

- Handout
- Reading: Bradsher, K. (2008, April 24). With first car, a new life in China. *New York Times*. Retrieved January 30, 2009, from http://www.nytimes.com/2008/04/24/business/worldbusiness/24firstcar.html
- TI-83 graphing calculator (or equivalent modeling tool, such as Excel)

Handout: Car Buyers in Asia

Crandall | Algebra and Trigonometry – Business and Finance (MAT115)

Due: ________________
Late papers will lose 10 points.

Car Buyers in Asia and in the U.S.

1. The table below gives data on passenger vehicle sales (cars, minivans, and sport utility vehicles in China.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Vehicles sold (in millions)	.6	.8	1.2	2.2	2.4	3.1	4.2	5.3	6.1

   a. Taking the year 2000 as t=0, make a scatter plot of the data using an Excel spreadsheet or a piece of graph paper.
   b. Using Excel (or a TI-83 graphing calculator) enter years since 2000 as x-values and vehicle sales in millions as y-values, and fit the data to an exponential equation.
   c. Using the equation in b), predict vehicle sales volume in China in 2015. What about 2030?
   d. In what year will sales volume reach 12 million vehicles?

2. The table below gives similar data on vehicle sales in India.

Year	2003	2004	2005	2006	2007	2008
Vehicles sold (in millions)	0.8	1.0	1.2	1.4	1.6	2.0

   a. Taking the year 2003 as t=0, make a scatter plot of the data using an Excel spreadsheet or a piece of graph paper.
   b. Using Excel (or a TI-83 calculator), enter years since 2003 as x-values and vehicle sales in millions as y-values, and fit the data to a quadratic best-fit model.
   c. Using your equation in b), predict the sales volume in India in 2015. What about 2030?
   d. In what year will sales volume in India reach 12 million vehicles?

3.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Vehicles sold (in millions)	13.8	13.5	13.3	13.0	13.1	13.1	12.8	12.4	12.0

   The table below gives data on vehicle sales in the United States.

   a. Taking the year 2000 as t=0, make a scatter plot of the data using an Excel spreadsheet or a piece of graph paper.
   b. Using Excel (or a TI-83 graphing calculator), enter years since 2000 as x-values and vehicle sales in millions in the U.S. as y-values; find the equation of the best line through the data.

   c. Using the linear equation that you found in b), predict the sales volume in 2015. What about 2030?

4. Assuming that vehicle sales in India continue to grow quadratically, and that vehicle sales in the United States continue to decrease linearly, in what year will the sales volume in these two countries be equal? What is the vehicle sales volume at this time? Do you think that this will ever happen? What assumptions must be questioned? Explain.

5. According to the article, "With First Car, a New Life in China," are Chinese domestic carmakers like Geely and Chery the main beneficiaries of the explosive growth in vehicle sales in China? Explain your answer.

6. Based on the reading, write a brief essay discussing how the status of automobile ownership is beginning to reconfigure traditional folkways in rural China.

7. Discuss the environmental consequences of the explosive growth of car sales in countries like India and China in terms of emissions/greenhouse gases and in terms of competition for (ultimately finite) energy resources.

Reading: Car Buyers in Asia

Crandall | Algebra and Trigonometry – Business and Finance (MAT115)

Source: Bradsher, K. (2008, April 24). With first car, a new life in China. *New York Times.* Retrieved January 30, 2009, from http://www.nytimes.com/2008/04/24/business/worldbusiness/24firstcar.html.

SHUANG MIAO, China – Li Rifu packed a lot of emotional freight into his first car. Mr. Li, a 46-year-old farmer and watch repairman, and his wife secretly hoped a car would better the odds of their sons, then 22 and 24, finding girlfriends, marrying and producing grandchildren.

A year and a half later, the plan seems to be working. After Mr. Li purchased his Geely King Kong for the equivalent of $9,000, both sons quickly found girlfriends. His older son has already married, after a short courtship that included a lot of cruising in the family car, where the couple stole their first furtive kisses.

"It's more enclosed, more clandestine," said Li Fengyang, Mr. Li's elder son, during a recent family dinner, as his bride blushed deeply.

Western attention to China's growing appetite for automobiles usually focuses on its link to mounting dependence on foreign oil, escalating demand on natural resources like iron ore, and increasing emissions of global warming gases.

But millions of Chinese families, like millions of American families, do not make those connections. For them, a car is something both simpler and more complicated.

J. D. Power and Associates calculates that four-fifths of all new cars sold in China are bought by people who have never bought a car before – not even a used car. That number has remained at that level for each of the last four years. By contrast, less than a tenth of new cars in the United States are purchased by people who have never bought a new car before, and less than 1 percent of all new cars are sold to people who have never bought a new or used care before.

China's explosive growth in first-time buyers is the driving force behind the country's record car sales, up more than eight-fold since 2000. It is the reason China just passed Japan to become the world's second-largest car market, behind the United States.

One change in Chinese attitudes is already clear and likely to have broad implications worldwide: even first-time buyers are becoming more sophisticated and want better cars.

China's domestic carmakers like Geely and Chery, once feared by Detroit and European automakers as eventual exporters to Western markets, have watched their sales gain modestly, stagnate or drop in the last year – even while the overall Chinese market has continued to grow roughly 20 percent a year.

The beneficiaries have been the joint ventures of multinationals that sell cars here that are designed overseas, like the Buick Excelle, Volkswagen Jetta and Toyota Camry. Practically every auto expert had expected the multinationals to lose market share rapidly to low-cost domestic automakers.

Instead, Chinese car buyers, including first-time buyers, have become more discriminating about the comfort, styling and reliability of the cars they buy. As a result, instead of planning to conquer overseas markets, local manufacturers are having to redouble their efforts in this market.

"Customers are moving up, they want the bigger, more established brands," said Michael Dunne, the managing director for China at J. D. Power. "They'd rather wait, save and buy higher on the ladder instead of buying a smaller car."

Back in the fall of 2006, the Li family did not want to wait, especially Mr. Li.

When the Li family bought their car, they agreed to extensive interviews with each family member in Shuang Miao, a rural village in east-central China's Zhejiang province. They later agreed to follow-up telephone interviews over the last year and a half and then a long family dinner in Shuang Miao last week to review their experience as first-time car owners. What emerges is a portrait of the rapidly expanding role of cars in the fast-changing ways in which China's people socialize, marry, raise families and, possibly, die.

Li Rifu was so excited on the day that he bought his first car in September, 2006, that he woke before dawn. He fixed breakfast for his wife and two grown sons, then climbed on his white motorcycle for a short trip he had been anticipating for many years.

Mr. Li had spent most of his life here in his ancestral farm village, nestled at the base of a steep hill. The embodiment of China's version of the American dream, he is largely self-taught. He learned to fix watches, and got a job as a foreman in a coal mine in nearby Anhui province by fixing the mine owner's watch. After saving some money, he came home to start a successful business that now employs five peasants raising flowers for landscapers.

That September morning, Mr. Li rode down the dirt alleys of his village and over a muddy, bamboo-lined stream where local women washed clothing on rocks jutting out into the sluggish current. He reached a four-lane paved road, then a six-lane road, and puttered on to his destination in the nearby city of Taizhou: a car dealership.

Over the course of the half-hour journey, Mr. Li was too excited to heed the persistent and unexplained pain at the base of his back.

He had really wanted a black car. But his sons preferred white, saying that it was a more popular choice for their generation, and Mr. Li had given in before he ever set out for the dealership.

"Without this car, my two sons wouldn't be able to find wives – the girls would not marry them," he said, reminiscing how when he courted his wife in the early 1980s, he only needed a bicycle. He ruined a half-dozen bicycle tires carrying her on the back of the bicycle for their outings together.

Mr. Li took a white Geely King Kong compact sedan for a short test drive, then returned to the dealership and climbed three flights of stairs to a cashier's office. He pulled a stack of currency thicker than a brick out of a black shoulder bag and paid the equivalent of $9,000 for the car; he would later pay another $1,000 in fees for a license plate.

"The next few days, everyone will want to drive it," he said proudly, a prediction that proved true. Mr. Li talked of his dream of someday driving across China to visit Beijing and Tibet, while acknowledging he would need more driver's education classes before those days-long journeys would be possible.

Car ownership helped Mr. Li bid for bigger contracts for more flowers. "My customers said, 'Wow, you came to visit me in a car' – it puts the negotiation on a whole different level," he said.

Several months after he bought the car, Mr. Li's elder son, Fengyang, did indeed find a girlfriend, Jin Ya, a beautiful young saleswoman for China Mobile, a cellphone service. In the space of five months, they had gone to the local marriage registry and been legally wed. Today, both say they want a child someday.

At the family dinner this week, Ms. Jin bridled at the idea that young women in China only consider a man to be marriage material if he can take them on dates in a car.

"Not me, not me!" she said passionately, before reluctantly acknowledging that, "Other girls do say that you need a car."

But as their Geely King Kong was bringing the Li family new joy – Mr. Li's increased business, Fengyang and Ya's courtship – tragedy struck: Li Rifu and his wife, Chen Yanfe, were each diagnosed with cancer.

Ms. Chen's reproductive tract cancer has gone into remission after $7,000 in medical bills. But Mr. Li's fist-sized malignant prostate cancer tumor – which turned out to be the cause of the mysterious back pain that was bothering him when he first bought the car – has resisted two surgeries and four rounds of chemotherapy. The cost: more than $40,000.

With payments from the local health insurance fund capped at $4,300 a person per year, Mr. Li has had to sell many of his possessions, and still he has had to go into debt. He wore a cap to the family dinner this week, sensitive about the loss of his hair due to the chemotherapy.

In two weeks, he will go to a leading hospital in Shanghai for more surgery, a five-hour drive to the north, followed by two more rounds of chemotherapy. But he will not be going in the family car: he sold it for nearly $8,000 last year to help cover his medical expenses, and cannot afford another one right now.

It is a common occurrence in this country, nominally communist, but with little or no safety net. While many families are scrambling into the middle class and buying cars, others are falling out of the middle class because of business reversals, medical bills or other problems, and are unable to buy replacements for their first car.

Zhu Jinyung, a machinery repairman who lives close to Shuang Miao, said that his family had bought a cheap, domestic car in 1994 after enjoying initial success in the plastic injection molding business.

"The business didn't work out," and the car had to be sold, he said.

Sadly, the Li family has known new tragedy recently. Their younger son, Fengwei, had also found a girlfriend with the help of the family car, the daughter of a manager at a large factory, an impressive person to Li Rifu. But the girlfriend's father was killed two weeks ago when a construction crane at the factory accidentally dropped its load on him after a crucial steel pin broke.

Despite it all, Li Rifu tries to remain optimistic. He now dreams of regaining his health, earning back the money he has spent on medical care and then – like a growing number of his countrymen – buying a bigger, more impressive car than the Geely compact he had to sell.

"If I get another car," he said, "I'll get a better-quality car, with even nicer seats and better steering."

Price Per Square Foot

Ladji Doumbia
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

Students will read articles about real estate pricing from Real Estate Libraries and Wikipedia in order to understand the concept of price per square foot of floor area. Then they will analyze data from the National Association of Home Builders (NAHB) about the average price per square foot of floor area of a one-family house in the USA from 1992 to 2006 using an Excel spreadsheet. Math skills relevant to this activity include (1) locating and graphing points, (2) finding the slope of a line, (3) graphing and solving linear equations, and (4) finding the equation of the line of best fit through a scatter plot. Furthermore, students will use that "regression line" to predict price trends in the future.

Math Topics
Linear functions

Purpose
Review, synthesis

Comments
Students need to know Excel

When to Introduce
Week 3

Activity Time Frame
Three weeks

Reflection

Many students plan to buy a house some day. To compare prices in different markets, locations, and months, the real estate industry uses either the median home price, the mean (average) home price, or the price per square foot.

The price per square foot of a house is obtained by dividing the median or average price of that house by its area. According to the real estate industry, the best tool to compare homes with different prices as well as homes of different sizes is the price per square foot of floor. Therefore, this activity focuses on the trends in price per square foot over time. After reading the background article, students are asked to analyze and interpret trends in the value of a one-family home based on price per square foot of floor. Students first study the broad shape of the data, then translate specific terms (slope, linear equation) in the handout questions (where units involved were price per square foot and time in years) into mathematical language, and relate these mathematical objects to concepts that they have learned in class.

In the first iteration of this activity, most students could relate questions to concepts via the language of math. Oddly, they did not use the TI83 graphing calculator to do the project, and, when asked why, they said that they could not get a printout of the graph on the calculator screen. Instead, they used Excel to conduct different parts of the project. Students were also asked to write a short essay about whether the price per square foot was always the best way of determining property values. Most of them submitted sound arguments to support their views.

After discussion with many colleagues, I improved the activity by asking students to give the price or rent per square foot of their own house or apartment and compare those to the average price per square foot in the northeast U.S.

Activity Overview

This activity should be introduced in the third week, at the end of the chapter on linear functions. The time breakdown should be:

Week 3

1.5 hour class time:

Distribute the project handout and reading: "Price per Square Foot??"

30 minutes class time:

Discussion and examples related to buying a house:

- Median price of a house
- Mean (average) price of a house
- Price per square foot of a house
- Rent per square foot of a house

1 hour class time:

Teach students how to use Excel to: make a scatter plot, find coefficients of a linear regression, get determination or correlation coefficients, and plot the regression line.

Week 4

(30 minutes class time): Continue activities undertaken in the previous week. Review key concepts about lines/linear equations.

Week 5

(30 minutes class time): Wind up and help students who are still struggling with the project.

Materials and Resources

- Handout
- Reading #1: Blank, S. Price per square foot. *Real Estate Libraries.* Retrieved January 30, 2009, from http://www.relibraries.com/pricePerSqft.aspx
- Reading #2: Wikipedia. *Real estate pricing.* (2009, January 23). Retrieved January 30, 2009, from http://en.wikipedia.org/wiki/Real_estate_pricing.
- National Association of Home Builders. (2008, August 7). *Price per square foot by location*. Retrieved February 10, 2009, from http://www.nahb.org/search_simple.aspx?txtkeyword=price+per+square+foot&x=0&y=0

Handout: Price Per Square Foot

Doumbia | Algebra and Trigonometry – Business and Finance (MAT115)

Average price per square foot of floor area in new one-family houses sold.

Price per square foot of floor area excludes value of improved lot

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Price per square foot	$55.18	$57.41	$60.21	$62.45	$64.38	$66.81	$67.83	$67.70	$70.43	$71.93	$75.68	$79.21	$85.13	$90.63	$91.99

Source: The National Association of Home Builders

1. To simplify years, take $t = 0$ for year 1992; take $t = 1$ for year 1993; take $t = 2$ for year 1994; take $t = 3$ for year 1995; take $t = 14$ for year 2006.
   a. What is the relationship between t and year?
   b. Treating time t as input and price P as output, enter the data in an Excel spreadsheet to make a scatter plot.
2. a. What is the slope $m1$ of the line passing through the points (0, 55.18) and (5,66.81)?
   b. Interpret the slope $m1$
   c. What is the P-intercept?
   d. What is the equation of the line passing through the points (0, 55.18) and (5, 66.81)?
3. a. What is the slope $m2$ of the line passing through the points (10, 75.68) and (13,90.63)?
   b. Interpret the slope $m2$.
   c. What is the equation of the line passing through the points (10, 75.68) and (13,90.63)?
4. Instead of working on portions of the scatter plots, we want to approximate the data by a line we can use to predict prices in the future. The line that will best fit the given data is called the linear regression. The approximation will be acceptable whether the determination coefficient R (r**2) is close to 1 or the correlation coefficient r is close to -1 or +1.
   a. Use your entered data to find the equation $y = ax + b$ of the best line through the data points and give the values of coefficients a and b, and of the determination coefficient R or correlation coefficient r.
   b. Use Excel to plot the scatter plot and the regression line on the same graph.
   c. Is the linear regression a visually good approximation of the data? Sustain your argument by a mathematical proof.
   d. Use the linear regression to predict the price per square foot of floor area in 2009.
   e. In what year will the price per square foot be greater than $100?

5. If your family owns a house or an apartment:
    a. Calculate, to the nearest foot, the floor area of your home.

    b. Knowing the buying price of your home, find the price per square foot of floor area of your house.

    c. Comparing the price per square foot of your home to those of your classmates, what borough offers the cheapest price per square foot and why?

    d. Should you buy a home in the New York area, or in another part of the northeast? Explain your reasoning.

6. If you are renting a house or an apartment:
    a. Calculate, to the nearest foot, the floor area of your home.

    b. Knowing the monthly rent of your house, find the rent per square foot of floor area of your home.

    c. Comparing your rent per square foot to those of your classmates, what borough offers the cheapest rent per square foot and why?

7. Based on your reading of the article, "Price Per Square Foot??" and the Wikipedia article on real estate pricing, write a short essay on whether price per square foot is always the best way to determine property value. Give cogent reasons to support your argument.

References

- National Association of Home Builders. (2008, August 7). *Price per square foot by location*. Retrieved February 10, 2009, from http://www.nahb.org/search_simple.aspx?txtkeyword=price+per+square+foot&x=0&y=0

Reading #1: Price Per Square Foot

Doumbia | Algebra and Trigonometry – Business and Finance (MAT115)

Source: Blank, S. Price per square foot. *Real Estate Libraries.* Retrieved January 30, 2009, from http://www.relibraries.com/pricePerSqft.aspx.

It's probably time someone addresses a widely used term that is loosely defined and almost never qualified: PRICE PER SQUARE FOOT! These four words have developed into a term almost everyone loves to toss into a conversation when talking about real estate as it relates to a city neighborhood. I rarely hear it used when describing a suburban neighborhood where the price per square foot factor would actually make some sense. Say you have a two-story home (let's call it the Belair model) that contains 2,000 square feet. Let's assume they were all built on a similar sized lot, have two car garages and full, open basements. Let's also say that the neighborhood is about ten years old. Now, if that Belair, or similar two-story home, sold for $200,000, it easily calculates out to $100 per square foot. You can make simple dollar adjustments, higher or lower, for things like central air, basement finishing, decor, etc. But, the bottom line is that the Belair model is selling for about $100 per square foot compared to other two-story homes in that neighborhood. Even ranch or tri-level styled homes will typically sell at a different price level in the same neighborhood.

Now, let's talk about PRICE PER SQUARE FOOT and how that term means virtually nothing in most of our city neighborhoods. You can choose almost any older neighborhood to illustrate the extreme, and yet wonderful, blend of value differences in neighborhoods such as Hilltop, Washington Park, Country Club, Cherry Creek, Park Hill, Lodo, etc. The obvious considerations when identifying different factors should include but, not be limited to, location, architectural styles, traffic patterns, newer construction vs. 50–100 years old, quality of construction, lot sizes, landscaping, updates and remodels, garages (1, 2 or 3/attached or detached), basements (finished/not finished) floor plans and room sizes, curb appeal and maintenance, and did I mention location (even in the same neighborhood or down the street). These factors can make tremendous differences in the value. The concept of price per square foot should only be used as a minor gauge in determining the value of a property. Let's pretend you're looking at two bungalows in Washington Park. They were both built in the 1920's and let's presume they're on the same block and are both 1,200 sq. ft. However, one is listed for $195,000 ($162.50 per sq. ft.) and the other is $285,000 (or $237.50 per sq. ft.). Initially, you would probably jump all over the $195,000 property. But, the better the value for you could very possibly be the more expensive home. No, I'm not nuts! Washington Park has plenty of examples of like-kind homes selling for $225 to $250 a foot. So the higher priced home is not a freak of nature. It likely has been completely renovated (new and upgraded electrical, plumbing, roof, new kitchen and baths, decor finishes, etc.) Maybe it includes a wonderfully finished basement, is on a larger, more well landscaped lot, has a better garage arrangement, is surrounded by larger more expensive homes, and various other factors. Unless you are willing, able and have the time and patients to make the improvements to the $195,000 home, the more expensive one could be the better value.

Many people might feel that a condo or a loft would be easier to talk price per square foot when comparing similar sized homes in the same or nearby building. Well, it is a little easier, but don't get carried away there, either. Many of the same factors will definitely apply; however, there are other important elements to consider also. Remember location! Now add the location of the floor and the views. Does the building have a storage facility? What is the availability of parking, what kind of amenities are on the premises, and how big is the maintenance fee relative to the benefits?

The long and the not-so-short of all this is; when you are shopping for you new home, work with a knowledgeable realtor and most importantly, choose the home that fits your needs the best and have it be the one that you can envision enjoying the most. And then, see how it stacks up to its current competition and possibly other like-kind sold properties. Just compare apples to apples!

Reading #2: Real Estate Pricing

Doumbia | Algebra and Trigonometry – Business and Finance (MAT115)

Wikipedia. *Real estate pricing.* (2009, January 23). Retrieved January 30, 2009, from http://en.wikipedia.org/wiki/Real_estate_pricing.

Real estate pricing deals with the valuation (finance) and there are three main methods: appraisals with comparable properties, capitalization rate comparisons with similar income producing properties, and discounted present value of expected future cash flows.

After realty prices are estimated, recorded or otherwise reported, there remain two major ways in which aggregate home prices are reported: median and mean (average). Prices are also calculated by square foot, using both the mean and median price. Real estate prices have had a profound impact on urban, as well as the suburban and rural landscape. The most important government measurement of home prices in the United States is the house price index. Median house prices are reported for metro areas and regions of the country by the private National Association of Realtors.

Median home price

The median home price is the threshold which divides the real estate market into two equal halves, in reference to pricing. One half of all homes in the market were sold at a price above the median home price, while the other half were sold below that price. For example, the median home price in the United States was $213,900 in the fourth quarter of 2005, meaning that half of all homes sold in the US were priced above $213,900, and half were priced below $213,900. In California, the median home price was $548,000.

The median home price is one of the most common measurements used to compare real estate prices in different markets, areas, and periods. It is said to be less biased than the average since it is not as heavily influenced by the top 2% of homes sold. For example, the average home sale price in the US was $264,000 in October 2005, compared with a median home price of $213,900 for the same time period.

Mean (average) home price

The mean home price, or average home price is the sum of prices of all homes sold in a certain area in a certain period, divided by the number of properties sold in the same area in that period. For example, say in a hypothetical townhouse complex there were five townhouses sold in March 2006. The properties were priced as follows: one for $450,000, one for $459,000, two for $465,000, and one for $499,000. The sum of all of these properties is $2,338,000. This number is then divided by five, which equals $467,600. Thus, the mean home price for a townhouse in this complex was $467,600 in March 2006.

Per square foot pricing

In per square foot pricing, the total price or rent of a unit is divided by the area of the unit.

Sales price per square foot

Sometimes real estate prices are measured by the price of each square foot. This allows for a better comparison between differently priced homes as well as homes of different sizes. In this pricing measurement method, the median or mean price of a home is divided by its area. For example, a 1,243 sq ft (115.5 m2). home was for sale for $465,000. To find the per square foot price, the price of $465,000 is divided by the area of 1,243 sq ft (115.5 m2). The result, $374.09, is the price per square foot for this particular home.

To effectively compare neighborhoods, the mean or median home price of a neighborhood is divided by the mean or median area. To refer to our example of Villawood Townhomes in Salinas, CA, the sold units in Willowood range from 1,243 sq ft (115.5 m2). to 1,621 sq ft (150.6 m2). The first four units are each 1,243 sq ft.; the fifth unit is a little larger, measuring 1,621 sq ft (150.6 m2). The area of all units combined is 6,593 sq ft (612.5 m2). This number is divided by five, the number of homes for sale, and the result, 1,318 sq ft., is the mean area. The mean price for the sold townhouses in Villawood of $467,600 is then divided by the mean area of 1,318 sq ft.; the result is a mean price of $354.78 per square foot. This also includes the lot the home is built on (which varies in size).

In cities where condos, co-ops and to some extent townhomes and row houses are more prevalent, the prices do not include the land, since that is not owned by the indiviual but the entire association (though older town homes and row houses sometimes are not part of associations). The size of city lots are generally much smaller than those in the suburbs, measuring sometimes a mere 20 feet (6.1 m) wide for a 3 or 4 flat apartment building, with little to no land left for vegetation.

Rent per square foot

Rent is also calculated by square foot. The rent per square foot is often used as an effective tool in comparing units and different markets, when units are of different sizes. For example, in March 2006, a given 1,600 sq ft (150 m2). single-family home in Aptos, California charged a monthly rent of $1,800. In order to find the rent per square foot, the rent of $1,800 is divided by the area of 1,600 sq ft., which gives a rent per square foot of $1.12.

Another given 1,140 sq ft (106 m2) single-family home in Aptos, CA had a rent of $1,595 per month. Again, the rent of $1,595 is divided by the area of 1,140 sq ft., which equals $1.40 per square foot. So, even though this home has a lower overall rent, its rent per square foot is actually higher than that of the first home.

Factors Influencing Real Estate Prices

The variables that drive residential real estate prices can be grouped into macro forces and micro forces. Macro forces include mortgage interest rates, economic strength (the business cycle), demographics, and federal taxes. Micro forces include local economic strength, state and municipal zoning, neighborhood features (such as quality of schools), and the condition of the property itself.

The biggest factor influencing home prices are income levels. Home prices are limited in how far they can rise by the incomes of potential buyers. Since eighty percent of all homes purchased are purchased with a mortgage, the ability to make payments, borrow money, and the cost of borrowing money are major influences limiting how far prices can rise before hitting resistance due to prices hitting levels where potential are unable to qualify. In general the ratio in the US are home values at 2-4 times income levels.

Responsible lenders use what they refer to as "front-end" ratio which consists of income/mortgage payments to determine how much of a mortgage a person or family can qualify for and safely handle. This front-end ratio is generally a maximum of 28% of a borrower's monthly gross income that can be allocated toward housing expenses including the mortgage payment, insurance and property taxes. For example, a lender would allow a person with a $5000 monthly gross income to allocate $1400 per month for mortgage payments, fire insurance and property taxes. ($5000 × 28% = $1400) So with $1200 available for monthly mortgage payments, after subtracting $200 for insurance and taxes, $1200 would support a $200,000 mortgage.

External effects

Real estate prices can have a profound impact on an area. They can cause urban decay, over crowding as well as an urban renaissance.

Decline

In Harlem and many other inner city areas of large American cities, real estate prices dropped due to lower demand and the resulting surplus in supply. This trend was largely caused by suburban migration. Lower real estate prices had a negative effect on landlords, who in these declining neighborhoods became known as "slumlords." Slumlords are notorious for not caring for the properties and letting them slip into a state of severe disrepair. Often, though, landlords in blighted urban areas did not have funds to care for their worthless and unprofitable properties. In many American slums, the situation became so dire that landlords were known to set their properties on fire in order to commit insurance fraud and collect the insurance policy payouts.

Urban Renaissance

In some areas, rising home prices have caused an urban renaissance. Rising home prices can transform unprofitable and decaying properties into potential gold mines. In many areas, landlords renovated their now-profitable properties, while other properties were bought by developers, who renovated them, seeing the neighborhoods' potential. Many downtown areas of large American cities have enjoyed a significant reawakening of interest in inner-city properties, which has rejuvenated these once blighted areas. Thanks in part to rising real estate prices, many inner cities have experienced a true urban renaissance. This can lead to gentrification.

The Life-Cycle Hypothesis

Alioune Khoule
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Project Quantum Leap

Objectives

The purpose of this project is to search for patterns, observe the parabolic shape of the plotted data, and use quadratic functions to model financial data. Students will review how to find the vertex of a quadratic function, and learn how to use a calculator, Excel or MAPLE to graph a function to fit a data set. Finally, students will be able to better understand the value of the quadratic function and how it enables us to predict the future, if such a model still holds.

Math Topics
Quadratic functions and scatter plots

Purpose
Review, synthesis

Comments
The abstract nature of math has created a lack of interest for some students, which is one of the reasons they don't strive to understand it. I have come to realize that a project based on quadratic functions is more engaging for the students simply because of the concrete resources available.

When to Introduce
Week 6

Activity Time Frame
Two weeks

Reflection

While I have taught a similar unit before, the development of the PQL project was new to me. It looks so simple to find the vertex of a quadratic function, and graph it. But the biggest question that most students ask is how a quadratic equation can be applied to their lives. To capture the students' attention on the day I introduced the project, I initiated a discussion with them about what goals they have. All students came to the conclusion that education is the way to get a better job, so they can live a better life. The next question I asked them was how they could make such a lifestyle sustainable. During the time that we spent discussing the project in class, I came to realize that students were more engaged in learning about the quadratic function as it models income over a lifetime than when I was teaching the quadratic topic traditionally. The project is a self-contained unit that I will be able to use again and develop further with each use.

Activity Overview

- As a class, students read the assigned questions and discuss what is necessary in order to complete the project (30 minutes).
- Review quadratic functions/parabolic graphs (2 hours).
- Learn how to use Excel (or a graphing calculator or MAPLE) to fit a curve to data (1 hour).
- Research the life-cycle hypothesis beyond reading the article (1 week period).
- As a class, discuss the project output for about 30 minutes, including how to write a reflective essay on the project.
- Hold a 5 minute one-on-one meeting with each student the week before the due date to gauge their progress and make sure that they are on the right track.

Materials and Resources

- Handout
- Reading
  - Schenk, R. The life-cycle hypothesis. *Cyber Economics*. Retrieved January 30, 2009, from http://ingrimayne.com/econ/FiscalDead/LifeCycle.html
  - Jappelli, T. & Modigliani, F. (1998, November 1). The age-saving profile and the life-cycle hypothesis. *Centre for Studies in Economics and Finance (CSEF) Working Papers*. Retrieved January 30, 2009, from EconPapers: http://econpapers.repec.org/paper/sefcsefwp/09.htm
- U.S. Census Bureau. (2009, February 3). *American community survey*. Retrieved February 11, 2009, from http://www.census.gov/acs/www/index.html

Handout: Life-Cycle Hypothesis

Khoule | Algebra and Trigonometry – Business and Finance (MAT115)

The following table shows the "Median Income I" of individuals of different age groups within the United States for 2001. For each age group, let the class midpoint represent the independent variable, x. For the age group "65 years and older," we will assume that the class midpoint is 69.5.

2001

Age	Class Midpoint, *x*	Median Income, *I*
15–24		$9,301
25–34		$30,510
35–44		$38,340
45–54		$41,104
55–64		$35,637
65 and older	69.5	$19,688

Source: U.S. Census Bureau. (2009, February 3). *American community survey*. Retrieved February 11, 2009, from http://www.census.gov/acs/www/index.html

1. Find the class midpoint for each class age.
2. Draw a scatter diagram of the data with input as class midpoint and output as median income.
3. Is the relation between the two variables a function? If yes, what type of function is it and what is its domain?
4. Use a graphing utility or Excel to find the function of best fit.
5. Use this function to determine the age at which an individual can expect to earn the most income.
6. Use the function to predict the peak income earned.
7. Graph the quadratic function of best fit and compare it to the scatter diagram in 2.
8. Based on the reading attached to this project, write a reflective essay of at least 600 words.

Reading: Life-Cycle Hypothesis

Khoule | Algebra and Trigonometry – Business and Finance (MAT115)

Sources:
Schenk, R. The life-cycle hypothesis. *Cyber Economics*. Retrieved January 30, 2009, from http://ingrimayne.com/econ/FiscalDead/LifeCycle.html

Jappelli, T. & Modigliani, F. (1998, November 1). The age-saving profile and the life-cycle hypothesis. *Centre for Studies in Economics and Finance (CSEF) Working Papers*. Retrieved January 30, 2009, from EconPapers: http://econpapers.repec.org/paper/sefcsefwp/09.htm

In examining why people spend the amount they do, a logical starting point is to ask what goals they have. Two goals seem reasonable for a great many people. First, they prefer a higher standard of living to a lower standard of living. In other words, people want the highest level of consumption spending they can get. Second, most people prefer to have a roughly constant standard of living through time. They do not like to live on a roller coaster, with one year of feast followed by a year of famine.

Together, these two goals suggest that people try to maintain the highest, smoothest consumption path that they can get. Presented in this way, discussion of consumption behavior becomes a problem that the tools of microeconomics are designed to examine (with budget lines and indifference curves).

Consider, for example, a person who will earn $10,000 this year and $5,000 next year. Ignoring all future years, how should he spend? The idea that he wants a smooth consumption path suggests that he should save part of this year's income and spend it next year. Alternatively, if the person earned the $5,000 this year and the $10,000 next year, the goal of a high smooth consumption path would require that he borrow in the first year and pay back in the second. An important function of financial markets from the point of view of consumers is that these markets help one maintain a constant standard of living despite fluctuations in income.

The idea that people have fluctuations in income that they want to smooth is the basis of the life-cycle hypothesis of consumption. In a series of articles in the 1950s and 1960s, Franco Modigliani, Richard Brumberg, and Albert Ando explored why people save. They found that people generally live longer than they earn income – that is, people usually retire. If people are to keep spending after they no longer earn income, they must accumulate assets while they are earning so that they can dissave. (Few are willing to lend to those who have no prospect of future income.)

Suppose a 20 year-old person expects to live 50 years more, but only to work for 40 of those years. He expects to earn $20,000 each year. Ignoring interest, this person will have earnings of $800,000 to spread over 50 years. If he spends $16,000 a year, he will die with zero assets left. To get this spending pattern, he saves $4,000 each year while he works, and at retirement will have assets of $160,000.

Now suppose that the person in the above example begins with assets of $200,000. He will then have a lifetime amount of $1,000,000 that can be spent. He will be able to spend $20,000 each year and die with zero assets. Thus the life-cycle hypothesis introduces wealth as a factor into the consumption function. Consumption can be financed either through income or through the sale of assets, and an increase in either should increase consumption.

By looking at what a "typical" individual should do, the life-cycle hypothesis builds microeconomic footings for the consumption function. Behavior is goal-directed in the life-cycle hypothesis, while it is not in the original Keynesian consumption function. This latter consumption function is mechanical without a reason. Since economists prefer behavior that can be explained in terms of people pursuing goals, it is no surprise that the life-cycle hypothesis has become popular.

The life-cycle hypothesis can be expanded to take into account uncertainty about when death will occur, the existence of social security, the interest rate, savings for bequests for heirs, and various patterns of lifetime earnings. It does not deal well with what should happen if incomes fluctuate erratically over time, but for this situation another theory, the permanent-income hypothesis, provides an answer. The permanent-income and life-cycle hypotheses are not contradictory theories, but theories that nicely complement each other (Schenk).

The life-cycle hypothesis posits that saving is positive for young households and negative for the retired, so that wealth should be hump-shaped. Yet, if one looks at the microeconomic evidence on saving by age, dissaving by the elderly is limited or absent. But the saving measures usually computed on cross-sections or panel data are based on a concept of income that does not take into account the presence of pension arrangements. In fact, disposable income treats pension contributions as taxes, and pension benefits as transfers. But since contributions entitle the payer to receive a pension after retirement, contributions should be regarded as life-cycle saving and hence included back to income. Similarly, pension benefits accruing to the retired do not represent income produced, but a drawing from the pension wealth accumulated up to retirement (Jappelli and Modigliani).

Rising Gas Prices Crisis: How Fast and Why?

Rudy Meangru
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Project Quantum Leap

Objectives

Students will use their mathematical knowledge of graphs and rate of change of a function to gain a better understanding of the rapid increase of gasoline prices. They will read an article from the *New York Times* to learn more about this problem that has had such a major impact on their lives. They will also be asked to review a table of the most recent gasoline prices from which they will construct graphs and perform calculations involving rate of change. In the end, students will be asked to provide reasons, based on an article they have read, for this increase in gas prices.

Math Topics
Graphs, slope, and rate of change

Purpose
Review, synthesis

Comments
This lesson is based on a reading and a table of values. Students need to have a basic knowledge of signed numbers, graphing, ratio, and linear trend.

When to Introduce
Start of second week

Activity Time Frame
Two days to complete Part 1 and two weeks to complete the remaining parts of the activity

Reflection

This activity addresses the theme of business and finance. Gasoline prices have always tended to rise over the summer months. However, recently, gasoline prices have been steadily increasing throughout the year. This increase may not impact people who drive only short distances, but for businesses that rely on gasoline to transport their products or conduct services, it is a severe blow. Local consumers experience this impact as businesses raise their commodity prices to offset the rising costs of operation. To understand this ripple effect one must first have a clear picture of the severity of the price increase over a period of time. Then a further investigation is warranted to explain the plausible reasons for such drastic change. I believe this process will motivate students to reflect on possible solutions to this problem.

In this activity, I am using a current crisis that students are aware of as the background to teach the concept of average rate of change. Students need to have basic number sense and understand the coordinate system. They must be able to read data and make appropriate calculations (in this case, rate of change).

The goal of this activity is to engage students with the topic, and through that, to apply the knowledge of rate of change to real data about gas prices. By doing this activity students will gain understanding of a growing economic crisis and realize that math can be useful to explain the full impact on our society. It also raises students' interest in becoming more proactive in advocating changes to resolve such a crisis. As the outcome of this activity, students should become more informed about the impact of gasoline price increases on their lives, and this awareness should encourage them to think of alternative ways of conserving precious fuel. Finally, students will be given the opportunity to reflect on this activity and share what they have learned. They should be able to articulate the impact that it has had on them personally as well as suggest changes they would be willing to advocate, based on this exercise.

After I implemented this activity, I noticed that most students felt comfortable with the mathematical topic. Afterwards they were more confident asking questions related to graphing and rate of change. For many of them this was the first time they had to read an article, extract numbers and data from it, and write supporting mathematical statements based on it. Even though some students did not produce great papers, they all seemed to master the mathematical concepts associated with this activity.

Activity Overview

This activity should be introduced at the start of the third week of the semester. It may be spread over a two-week period, depending on assigned laboratory time.

The activity can be handed out in advance and the faculty should briefly discuss the expectations. The reading material should also be done prior to the lesson on "rate of change." This time frame will give the students an opportunity to do the reading and search for other articles on the same topic that may be of interest to them.

After the math lesson has been taught, there should be a brief description of the activity and a general discussion of the impending crisis. By this time the student should have read the assigned article and should be familiar with the topic. This discussion should take no more than 30 minutes and will clarify students' questions and make them more engaged and interested about the problem at hand.

As the week progresses, a few minutes of class time should be set aside to answer any questions about the activity and/or to provide an indication of what stage of the activity they should have reached.

At the end of the one-week period, a draft of students' work should either be collected or posted electronically on Blackboard for feedback from the instructor. At least one opportunity should be given for revision.

If time permits, students can be asked to write a sample letter to be sent to their local representative about the severity of this problem and their suggestions for possible solutions.

Materials and Resources

- Handout
- Reading: Mouawad, J. (2008, May 7). Gas prices expected to peak in June. *New York Times*. Retrieved January 30, 2009, from http://www.nytimes.com/2008/05/07/business/07oil.html?partner=rssnyt
- Energy Information Administration. (n.d.) *Retail gasoline historical prices.* Retrieved February 11, 2009, from http://www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_history.html

Handout: Rising Gas Prices

Meangru | Algebra and Trigonometry – Business and Finance (MAT115)

Read the *New York Times* article, "Gas Prices Expected to Peak in June," by Jad Mouawad, May 7, 2008, and answer questions 1–5 below.

1. What does the author mean by the expression "average of $3.73"?
2. What does the term "barrel" mean?
3. It is stated that the price of oil went up to $121.84 a barrel, which was a 1.6% rise. What was the original price?
4. What is the current price for a barrel of oil? Be sure to cite your source.
5. What do you think the author means when he says, "cutting the tax would spur more consumption, pushing prices back up"?

Consider the following table of the average price for regular grade gasoline in New York City.

7/28/08	8/4/08	8/11/08	8/18/08	8/25/08	9/1/08	9/8/08	9/15/08
$4.056	$3.986	$3.890	$3.759	$3.675	$3.637	$3.588	$3.644

Source: Energy Information Administration. (n.d.) *Retail gasoline historical prices*. Retrieved February 11, 2009, from http://www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_history.html

6. What do you observe about the gas prices over this period?
7. What do you think may have caused the increase on 9/15?
8. Draw a scatter plot of the date vs. price.
9. Describe the trend in the graph.
10. Compute the weekly average rate of change for each time period.
11. What sorts of increases/decreases do you observe? Is it going up/down gradually or rapidly?
12. Assuming this pattern continues, what estimate can you suggest for the price on 9/29? Justify your answer.

Summary

Write a short reflective essay on what you have learned from this activity. How did it strengthen your mathematical skills? In what way did you connect the math to a real situation? Do you feel that this crisis has an impact on your daily life? If so, in what way? If not, explain why not. What factors do you feel may be responsible for this crisis? Cite evidence from a recent article to support your claim.

Reading: Gas Prices Expected to Peak in June

Meangru } Algebra and Trigonometry – Business and Finance (MAT115)

Source: Mouawad, J. (2008, May 7). Gas prices expected to peak in June. *New York Times*. Retrieved January 30, 2009, from http://www.nytimes.com/2008/05/07/business/07oil.html?partner=rssnyt .

John Partipilo/The Tennessean via The Associated Press

With gasoline prices at record highs, a station in Nashville posted prices in terms other than dollars and cents on Sunday. Gasoline sells currently for $3.61 a gallon on average, AAA says.

Oil jumped to another record on Tuesday, and the government said it expected gasoline prices to peak at a national average of $3.73 a gallon in June, just as the summer driving season kicks off.

Times Topics: Oil (Petroleum) and Gasoline
The new forecast from the Energy Department came on a day oil futures rose above $122 a barrel in New York trading after rebels in Nigeria renewed their attacks against oil installations. By day's end, crude oil for June delivery closed at a record $121.84 a barrel, up 1.6 percent from Monday's close.

Oil prices have nearly doubled in a year. Gasoline is selling for a national average of about $3.61 a gallon, according to AAA, the automobile club, a penny less than the record set on May 1 but 58 cents higher than a year ago.

Some private analysts have gone beyond the Energy Department's forecasts, predicting that gasoline will surpass $4 a gallon this summer.

Domestic gasoline consumption is likely to fall more steeply than expected this year, the Energy Department said, an indication that higher prices are cutting into the driving habits of many Americans. But gasoline prices are expected to rise nonetheless and should average $3.52 a gallon for the full year, or 71 cents above their average price in 2007, according to the government's latest estimates.

"In the past, high prices could be offset by borrowing or making more money," said Adam Robinson, an analyst at Lehman Brothers. "It's really when you have the triple bite – a weaker economy, less access to credit, and higher prices – that you see the consumer recoil."

The high cost of fuel has become a major issue in the presidential race, with the Democratic candidates, Senators Hillary Rodham Clinton and Barack Obama, clashing over a summer waiver of the 18.4-cents-a-gallon federal gasoline tax.

The gas tax holiday is supported by Senator Clinton and the presumptive Republican nominee, Senator John McCain, who have both said it would provide some relief in the summer driving season. Senator Obama calls the idea "pandering" and said that cutting the tax would spur more consumption, pushing prices back up.

In its monthly report, the Energy Department projected that domestic petroleum consumption would decline by about 190,000 barrels a day this year, a result of the economic slowdown and high prices. That is a sharper drop than the 90,000-barrel-a-day decline projected by the department last month.

After accounting for increased ethanol use, domestic consumption will fall by 330,000 barrels a day, or less than 1 percent of total gasoline demand. While limited, it would be the first annual decline in gasoline demand since 1991.

The Energy Department expects oil prices to average $110 a barrel this year, about $9 more than its previous outlook.

Despite these higher costs, global oil demand is still projected to rise by 1.2 million barrels a day this year, mostly because of growing consumption in China, the Middle East, Russia, Brazil and India.

China alone will account for a third of the jump in consumption. In March, Chinese imports rose by 800,000 barrels a day, compared with levels a year earlier, a big increase that could mean China is filling its oil reserve needs before the start of the Olympic Games this summer.

Oil supplies, meanwhile, continue to lag behind. After a drop in Nigerian output last month, production by OPEC nations fell 1 percent in April, according to a survey by Bloomberg News.

Members of the Organization of the Petroleum Exporting Countries pumped an average of 32.1 million barrels a day last month, down 320,000 barrels from March, according to the survey of oil companies, producers and analysts.

Nigerian production dropped by 160,000 barrels, to an average of 1.88 million barrels a day, the country's lowest level since August 1999. The country's output suffered from a strike by Exxon Mobil workers. Adding to these troubles, rebel militants have apparently resumed their attacks on oil companies in the Niger Delta, forcing Royal Dutch Shell to reduce production. As demand continues to outpace the growth in oil supplies, analysts expect little relief in prices. A shortfall in supplies over the next two years will probably send oil to $150 to $200 a barrel, Goldman Sachs said in a new report.

Analysts' forecasts for the price of gasoline over the next few years run as high as $7 a gallon.

Investment Rates

Margareta Szczapstefanowski
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Project Quantum Leap

Objectives

In this inquiry activity students will explore how to calculate interest rates using different methods of compounding interest. Students will calculate interest and find balances in a CD account after specified times. Then, they will try to generalize an observed pattern in order to obtain a formula for finding the CD balance as a function of time. Students will also graph their results and use their graphs to estimate values. This is a motivational activity preparing students for the study of exponential functions.

Reflection

This activity is specifically for students enrolled in MAT115 sections. It presents methods of compounding interest (annually, semiannually, quarterly, monthly, and daily) starting with specific numerical examples that lead to graphs and moving to generalizations that yield formulas. Students will develop a deeper understanding of the different methods of compounding interest. The topic will be of interest to students because the experience of completing this activity will enable them to make decisions about their investments. It provides them with the tools necessary to make their own calculations and estimates in order to decide what investment options are best for them. Researching the method of compounding interest from an actual bank should make this experience even more real for students. This activity brings math to life, and will surely be engaging for students.

Math Topics
Introduction to exponential functions that requires students to make tables, graph, and write generalizations and formulas

Purpose
Motivation

Comments
This activity breaks down the method of compounding interest starting with specific numerical examples and graphs and moving to generalizations that lead to formulas. This activity was written specifically for high school students enrolled in MAT115 sections.

When to Introduce
The activity should be introduced in the seventh week of the semester, one and one-half weeks prior to introducing exponential functions (about lesson 24 or 25).

Activity Time Frame
Two class sessions are required to complete Part 1 of the activity, with students working in small groups. Two additional weeks will be needed in order to complete subsequent parts of the activity independently and to write a summary reflective essay.

Activity Overview

Homework 1 (see Handout #1) needs to precede the inquiry activity. It should be assigned a day (or two days) before introducing the activity. Students are asked to learn vocabulary necessary for understanding the activity. Students will calculate interest compounded annually and find balances in a CD account at specified time periods. Students will also graph their results in order to estimate account balances graphically.

Part 1 of the activity (see Handout #1) requires one class session for students working in small groups (three students, ideally). The instructor must check to see that students grasp the ideas presented, come to proper generalizations, and write the correct formula for finding the account balance when the interest is compounded annually. Students may need to clarify occasional confusion or misconceptions.

Part 2 of the activity (see Handout #2) can be assigned as homework. The instructor may want to collect the homework or review it quickly in class to make sure that students have arrived at the correct formula for compounding interest semiannually. It is crucial to check that students have correctly completed Part 2 of the activity, because otherwise misconceptions may extend into later activity assignments.

Other parts of the activity (see Handout #2) can be assigned as homework over a two-week period. Parts 3 through 5 of the activity ask students to derive formulas for calculating account balances with quarterly, monthly, and daily compounding of interest. Part 6 requires students to give advice on choosing an optimal investment strategy. In Part 7 students will obtain information from an actual bank and learn what method of compounding interest is used by that bank. In Part 8 students will write a reflective essay. While students are completing Parts 3 through 7, a small portion of class time should be reserved for answering questions.

Materials and Resources

Handout #1: Annual Investment Rates

Handout #2: Other Investment Rates

Handout #1: Annual Investment Rates

Szczapstefanowski | Algebra and Trigonometry – Business and Finance (MAT115)

Alex has $1,000 to invest and has gone to different banks to check investment options. He decides to invest in a one-year CD account, which he plans to renew if he does not need the money to cover his expenses.

He wants to make a careful decision in order to earn the most money. However, at this point, he does not understand which offer is best for him. To understand the process of how different banks calculate a balance on CD accounts, he decides to use math.

Part 1: Annual Investment Rates (Homework 1)

Write definitions of the following vocabulary words, either from a dictionary or in your own words:

Deposit ____

____

Withdrawal ____

____

Balance ____

____

Annual ____

____

Semiannual ____

____

Alex has $1,000 to invest. The Penny Bank offers a 5.0 % annual rate on a one-year CD account compounded annually.

Use the following formula to calculate interest compounded annually:

Interest = (Invested Amount)(Annual Interest Rate)

Assume Alex does not make any deposits or withdrawals.

1. Answer the questions below. Include all the mathematical steps you take in order to arrive at your answers.
   a) How much interest will he earn after one year when his CD account matures?
   b) What will Alex's account balance be after the first year?
   c) What will Alex's opening balance be for the second year?
2. Complete the table below, showing the growth of Alex's investment over the first 5 years.

Show the mathematical work in the table. Round your answers to the nearest cent.

3. Estimate (make an educated guess) how long it will take for Alex's money to double.

Time (years)	Balance: amount in Alex's account (dollars)
0	
1	
2	
3	
4	
5	

4. Graph the points in the above table. Let x represent the number of years and y the balance in Alex's account after x number of years. (Attach the graph to your work.)
5. What type of graph do the points follow? Explain.
6. Connect the points with a smooth curve. Use the graph to estimate the time it will take for Alex's investment to double. Write your estimate below.
7. Was your guess from #3 close to your estimated value in #6? Were you surprised by the value of your estimate?

Part 1: Annual Investment Rates (Class Inquiry 1)

8. Let's take another approach to understanding the values you found in the table in Part 1, question 2. Look for a pattern in the table below. Complete the table by following the pattern you found.

Time (years)	Balance (dollars): from question 2	Balance (dollars): Different Approach
0	1,000	1,000
1	1,050	$1{,}000 + 1{,}000(0.05) =$ $1{,}000(1 + 0.05) =$ $1{,}000(1.05)$
2	1,102.5	$1{,}000(1 + 0.05)(1 + 0.05) =$ $1{,}000(1 + 0.05)^2 =$ $1{,}000(1.05)^2$
3	1,157.63	
4	1,215.51	
5	1,276.28	
x		

9. Let A_0 represent the initial investment (original amount invested). Complete the table below.

10. What will the balance in Alex's account be after *x* years if he invests A_0 dollars?

Time (years)	**Balance (dollars): from question 2**	**Balance (dollars): Different Approach**	**Balance with initial investment of A_0**
0	1,000	1,000	
1	1,050	$1{,}000 + 1{,}000(0.05) =$ $1{,}000(1 + 0.05) =$ $1{,}000(1.05)$	$A_0 + A_0(0.05) =$ $A_0(1 + 0.05) =$ $A_0(1.05)$
2	1,102.5	$1{,}000(1 + 0.05)(1 + 0.05) =$ $1{,}000(1 + 0.05)^2 =$ $1{,}000(1.05)^2$	$A_0(1 + 0.05)(1 + 0.05) =$ $A_0(1 + 0.05)^2 =$ $A_0(1.05)^2$
3	1,157.63		
4	1,215.51		
5	1,276.28		
x			

11. Using the results from #10, rewrite the result where *x* is the number of years and *y* is the balance after *x* years.

12. Check to see that each entry from the table in part 8 satisfies the equation you wrote in part 10. Show one example below.

13. Use the equation from #10 to find the balance in Alex's account after:
    a. 0 years
    b. 5 years
    c.. 10 years
    d. 15 years
    e. 20 years
    f. 25 years

Organize this information in a table (write it below).

14. Graph the points in the table above. Draw a smooth curve to connect the points. (Attach the graph to your work.)

15. What does the y-intercept represent?

16. Does the curve rise more and more steeply, or more and more gently, as time goes by?

17. What would an increase in the y-intercept mean? Explain.

18. What would it mean if the curve rose more steeply earlier on?

Part 1: Annual Investment Rates (Generalization)

19. Write the formula for the balance after x years if a person invests A_0 in a CD account with r% annual interest rate compounded annually. (You may want to test your formula using the values you have already found, or by choosing new simple examples.)

Part 1: Annual Investment Rates (Applications)

20. Find the balance if Ben invests $5,000 in a CD account for 3 years at a 4.45% annual rate compounded annually. Show your work.

21. Henry invests $3,350 at 8.25% compounded annually. Write an equation giving the balance in Henry's account over time in years. Define the variables you use.

22. Write a problem that corresponds to the equation below:
$Y = 900(1 + 0.06)^4$

Handout #2: Other Investment Rates

Szczapstefanowski | Algebra and Trigonometry – Business and Finance (MAT115)

Part 2: Semiannual Investment Rate

Alex has already seen how much money he can earn if he invests his money ($1,000) in the Penny Bank, which offers a 5.0 % annual rate on a one-year CD account compounded annually.

Now, Alex is going to explore other options in other banks. He still has the same $1,000 to invest. The Nickel Bank also offers a 5.0 % annual rate on a one-year CD account; however; the interest is compounded semiannually.

Assume Alex does not make any deposits or withdrawals.

1. Answer the questions below. Include all the mathematical steps you take in order to obtain your answers.
   a. How much interest will the account earn after the first half year?
   b. What will be the amount in Alex's account after half a year?
   c. How much interest will the account earn after the first year when his CD account matures?
   d. What will Alex's balance be after the first year?
2. Complete the table below showing the growth of Alex's investment over the first 5 years. Show the mathematical work in the table. Round your answers to the nearest cent.

Time (years)	Balance: amount in Alex's account (dollars)
0.5 (or ½)	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	

3. Use the graph from #4 in Part 1 of the activity to graph the points in the above table. Remember, ***x*** represents the number of years and ***y*** the balance in Alex's account after ***x*** number of years. (Attach the graph to your work.)

4. Connect the points with a smooth curve. Use the graph to estimate the time it will take for Alex's investment to double. Write your estimate below.

5. At which bank, the Penny Bank or the Nickel Bank, will Alex double his money faster? Explain.

6. Compare the graph showing Alex's balance over the first five years when he invests $1,000 in the Penny Bank (#4 in Part 1) with the graph showing Alex's balance over the first five years when he invests $1,000 in the Nickel Bank (#4 in Part 2).

   Which curve rises more steeply? What does this rise mean?

7. Let A_0 represent the initial investment (original amount invested). Let's take another approach to understanding the values you found in the table in Part 2. Look for a pattern and complete the table below as you did in #9 of Part 1 of the activity.

Time (years)	**Balance (dollars): Different Approach**	**Balance with initial investment of A_0**
0	1,000	A_0
0.5		
1.0		
1.5		
2.0		
x		

8. What will be the balance in Alex's account after x years if he invests A_0 amount of dollars in the Nickel Bank?

9. Using the results from #8, rewrite the result where x is the number of years and y is the balance after x years.

10. Check to see that each entry from the table in #8 satisfies the equation you wrote in #9. Show one example below.

Part 2: Semiannual Investment Rates (Generalization)

11. Write the formula for the balance after x years if a person invests A_0 in a CD account with r% annual interest rate compounded semiannually. (You may want to test your formula using the values your have already found, or by choosing new simple examples.)

Part 3: Quarterly Investment Rate

Alex has already learned how much money he can earn if he invests his money ($1,000) in the Penny Bank, which offers a 5.0 % annual rate on a one-year CD account compounded annually, and in the Nickel Bank, which offers a 5.0 % annual rate on a one-year CD account compounded semiannually.

Alex wishes to explore other options in other banks. Remember, he still has the same $1,000 to invest. The Dime Bank also offers a 5.0 % annual rate on a one-year CD account; however, the interest is compounded quarterly.

Assume Alex does not make any deposits or withdrawals.

12. Answer the questions below. Include all the mathematical steps you take in order to arrive at your answers.
    a. How much interest will the account earn after the first quarter of a year (the first 3 months)?
    b. What will be the amount in Alex's account after the first quarter of a year?
    c. How much interest will Alex earn after the first half of a year?
    d. What will Alex's account balance be after the first half of a year?

13. Complete the table below showing the growth of Alex's investment over the first 5 years. Show the mathematical work in the table. Round your answers to the nearest cent.

Time (years)	Balance: amount in Alex's account (dollars)
0.25 (or ¼)	
0.50 (or ½)	
0.75 (or ¾)	
1.00	
1.25	
1.50	
1.75	
2.00	
3.00	
4.00	
5.00	

14. Use the same graph (from #4 in Part 1 and #4 in Part 2 of the activity) to graph the points in the above table. Remember, x represents the number of years and y the balance in Alex's account after x number of years. (Attach the graph to your work.)

15. Connect the points with a smooth curve. Use the graph to estimate the time it will take for Alex's investment to double. Write your estimate below.

16. At which bank, the Penny Bank, the Nickel Bank, or the Dime Bank, will Alex double his money fastest? Explain.

17. Compare the graph showing Alex's balance over the first five years when he invests $1,000 in the Penny Bank (#4 in Part 1) with the graph showing Alex's balance over the first five years when he invests $1,000 in the Nickel Bank (#4 in Part 2) and with the graph showing Alex's balance over the first five years when he invests $1,000 in the Dime Bank (#14 in Part 3).

    Which curve rises most steeply? What does this rise mean?

18. Let A_0 represent the initial investment (original amount invested). Again, let's take another approach to understanding the values you found in the table in #13. Look for a pattern and complete the table below the same way you have in previous parts of the activity.

Time (years)	Balance (dollars): Different Approach	Balance with initial investment of A_0
0	1,000	A_0
.25		
.50		
.75		
1.00		
x		

19. What will be the balance in Alex's account after x years if he invests A_0 amount of dollars in the Dime Bank?

20. Using the results from #19, rewrite the result where x is the number of years and y is the balance after x years.

21. Check to see that each entry from the table in #18 satisfies the equation you wrote in #20. Show one example below.

Part 3: Quarterly Investment Rates (Generalization)

22. Write the formula for the balance after x years if a person invests A_0 in a CD account with r% annual interest rate compounded quarterly. (You may want to test your formula using the values you have already found, or by choosing new simple examples.)

Part 4: Monthly Investment Rate

Alex has already learned how much money he can earn if he invests his money ($1,000) in the Penny Bank (5.0 % annual rate on a one-year CD account compounded annually), in the Nickel Bank (5.0 % annual rate on a one-year CD account compounded semiannually), and in the Dime Bank (5.0 % annual rate on a one-year CD account compounded quarterly).

Alex wants to explore another option in one more bank. Remember, he still has the same $1,000 to invest. The Dollar Bank also offers a 5.0 % annual rate on a one-year CD account; however, the interest is compounded monthly.

Assume Alex does not make any deposits or withdrawals.

23. Complete the table below showing Alex's balance over the first 3 months. Show the mathematical work in the table. Round your answers to the nearest cent.

Time (years)	Balance: amount in Alex's account (dollars)
1	
2	
3	

24. Complete the table below showing the growth of Alex's investment over the first 5 years. Show the mathematical work in the table. Round your answers to the nearest cent.

Time (years)	Balance: amount in Alex's account (dollars)
1	
2	
3	
4	
5	

25. Use the same graph as in Part 1, Part 2, and Part 3 of the activity to graph the points in the above table. Remember, x represents the number of years and y the balance in Alex's account after x number of years. (Attach the graph to your work.)

26. Connect the points with a smooth curve. Use the graph to estimate the time it will take for Alex's investment to double. Write your estimate below.

27. Compare this graph with the other graphs. Which curve rises most steeply? What does this rise mean?

28. Let A_0 represent the initial investment (original amount invested). Let's take another approach to understanding the values you found in the table in #24. Look for a pattern and complete the table below.

Time (years)	Balance (dollars): Different Approach	Balance with initial investment of A_0
0	1,000	A_0
1		
2		
3		
x		

29. What will the balance in Alex's account be after x years if he invests A_0 amount of dollars in the Dollar Bank?

30. Use the results from #29. Rewrite the result where x is the number of years and y is the balance after x years.

31. Check to see that each entry from the table in #28 satisfies the equation you wrote in #30. Show one example below.

Part 4: Monthly Investment Rates (Generalization)

32. Write the formula for what the balance will be after x years if a person invests A_0 in a CD account with an r% annual interest rate compounded monthly. (You may want to test your formula using the values you have already found or by choosing new simple examples.)

Part 5: Daily Investment Rate

Alex has already learned how much money he can earn if he invests his money ($1,000) in the Penny Bank (5.0 % annual rate on a one-year CD account compounded annually), in the Nickel Bank (5.0 % annual rate on a one-year CD account compounded semiannually), in the Dime Bank (5.0 % annual rate on a one-year CD account compounded quarterly), and in the Dollar Bank (5.0 % annual rate on a one-year CD account compounded monthly).

Alex wants to explore one last option in one more bank. Remember, he still has the same $1,000 to invest. The Currency Bank also offers a 5.0 % annual rate on a one-year CD account; however, the interest is compounded daily.

Assume Alex does not make any deposits or withdrawals.

33. Complete the table below showing the value of Alex's investment over the first 3 days. Assume a year has 365 days. Show the mathematical work in the table. Round your answers to the nearest cent.

Time(years)	Balance: amount in Alex's account (dollars)
1	
2	
3	

34. Complete the table below showing the growth of Alex's investment over the first 5 years. Show the mathematical work in the table. Round your answers to the nearest cent.

Time (years)	Balance: amount in Alex's account (dollars)
1	
2	
3	
4	
5	

35. Use the same graph as in Part 1, Part 2, and Part 3 of the activity to graph the points in the above table. Remember, x represents the number of years and y the balance in Alex's account after x number of years. (Attach the graph to your work.)

36. Connect the points with a smooth curve. Use the graph to estimate the time it will take for Alex's investment to double. Write your estimate below.

37. Compare the new graph to the other graphs. Which curve rises most steeply? What does this rise mean?

38. Let A_0 represent the initial investment (original amount invested). Let's take another approach to understanding the values you found in the table in #34. Look for a pattern and complete the table below.

Time (years)	**Balance (dollars): Different Approach**	**Balance with initial investment of A_0**
0	1,000	A_0
1		
2		
3		
x		

39. What will be the balance in Alex's account after x years if he invests A_0 dollars in the Currency Bank?

40. Using the results from #39, rewrite the result where x is the number of years and y is the balance after x years.

41. Check to see that each entry from the table in #38 satisfies the equation you wrote in #40. Show one example below.

Part 5: Daily Investment Rates (Generalization)

42. Write the formula for the balance after x years if a person invests A_0 in a CD account with an r% annual interest rate compounded daily. (You may want to test your formula using the values you have already found, or by choosing new simple examples.)

Part 6: Advice for Alex

Alex has already learned how much money he can earn if he invests his money ($1,000) in the Penny Bank (5.0 % annual rate on a one-year CD account compounded annually), in the Nickel Bank (5.0 % annual rate on a one-year CD account compounded semiannually), in the Dime Bank (5.0 % annual rate on a one-year CD account compounded quarterly), in the Dollar Bank (5.0 % annual rate on a one-year CD account compounded monthly) and in the Currency Bank (5.0 % annual rate on a one-year CD account compounded daily).

Based on the information you have found while completing this activity, write one paragraph giving Alex advice on where he should invest his money. Explain, either through specific examples or using generalizations, why you would give Alex this particular advice.

(Include this paragraph in your activity packet.)

Part 7: Research

Research and/or gather information from a real bank on how it calculates interest on one-year CD accounts (you may also wish to ask about other types of accounts).

Write a summary of the information obtained, providing the source(s) you used.

(Include this summary in your activity packet.)

Part 8: Reflection Essay

Write a one-page reflection essay describing what you have learned from this activity. You should include a discussion of what patterns you noticed, what generalizations you found, and what information you researched. How can you use the knowledge you have gained to make better financial decisions in your life? (Include this essay in your activity packet.)

Modeling Data Related to Health Care in the U.S.

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Project Quantum Leap

Objectives

This activity will raise students' awareness of economic concerns related to the U.S. health care system on the eve of health care reform, and reinforce students' knowledge of linear functions.

Students will read an article entitled "Health Care Facts: Costs" that documents past and projected (rising) health care costs. This article sheds light on the complex nature of national health care spending and the economic burden health care costs can place on American households, small businesses and the American economy as a whole. Accompanying data and graphs for years 2000–2007 will show trends related to the general health of Americans and to the sale of prescription drugs. Students will model this data using linear regression models in Excel, generate linear equations, and make predictions.

Math Topic
Application of linear equations

Purpose
Review of math topic

When to Introduce
Week 4–5

Activity Time Frame
One class discussion period. Due in 2 weeks

Reflection

In light of the current health care reform debate (2010–2011), this assignment is timely and relevant. Clearly, good and affordable health care is a necessity for every household. In prior classes, students have reflected on the need to understand health care issues as they relate to voting and to their own lives.

Students will start by identifying healthcare issues within their own households and families, thus building motivation to learn data analysis techniques using Excel. In order to foster discussion during the data analysis, it is best to place students in groups. Each group should have at least one student proficient in Excel.

Activity Overview

This project should be assigned about 4–5 weeks into the semester, after linear equations have been covered. Give students about two weeks to complete the project, preferably working in groups (2–3 students/group).

Week 4, Period 1: After Lesson 9 (Applications of Linear Functions), distribute and discuss the reading "Health Care Facts: Costs." Encourage students to do further research on the topic online.

Week 5, Period 1: Consult with students on their projects and review numerical results.

Week 5, Period 2: Students discuss their projects, including written reflections based on their analyses, with the instructor. The final assignment is due the following week.

Commodity Prices: Who Controls the Price of Food?

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Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

The primary objective of this project is to help students understand the concept of commodities and the impact of commodity prices on the quality of life in various nations around the world. This is also a lesson on fitting data points and extracting various quantities from linear, quadratic, and exponential models. Linear functions are encountered from Lesson 2 to Lesson 13 in the syllabus of College Algebra and Trigonometry (MAT115); quadratic functions are encountered in Lessons 20 to 25, and exponential functions are encountered in Lessons 31 and 32. This lesson can be introduced any time after the linear and quadratic functions are covered.

Math Topic
Graphing linear equations, equation of a straight line, applications of linear and quadratic functions

Purpose
Review, synthesis, reflection and analysis

When to Introduce
Any time after Lesson 20

Activity Time Frame
Two weeks

Through this activity, students are expected to achieve the following:

- Read news articles about commodities and food prices;
- Understand the factors that determine the prices of food and how the prices of food can affect the rest of the world;
- Think critically about who really benefits from high commodity prices;
- Plot a set of data in Excel and fit the points to a linear function. Find the slope and equation of the linear function and use these to predict or estimate other data points. Plot a set of data in Excel, fit the points to a quadratic function, and use the quadratic function to estimate or predict other data points; and,
- For extra credit, students can plot a set of data in Excel and fit the points to an exponential function

Reflection

This challenging project introduces students to the concept of "commodities." Students investigate how commodity futures are traded, studying price fluctuations of various commodities over the last two decades. They examine the graphs of various commodity prices over time, and extract information and patterns from the graphs.

They also read about the factors influencing food prices, as well as the real but unspoken social consequences of spikes in food prices. Through a series of guided questions, students must think critically and draw conclusions as to who benefits from legislation or economic activity affecting food prices. Finally, students must formulate a well-supported argument as to whether commodity trading should be subject to public monitoring or regulation.

You will need to spend time in the lab to help students with this activity.

- First, if you haven't introduced fitting using Excel, do so through this activity.
- We recommend that you briefly explain the concept of rate of change and average rate of change, and perhaps review percent increase and decrease, before tackling Question 5.
- The activity relies on getting data from online sites. The sites are all trustworthy, but you will have to show the students how to copy one row of data into each Excel table; the students can then obtain and table the remaining data on their own. Time permitting, have students complete the table in the lab so that you can monitor for comprehension and accuracy.
- Before students do the reading, discuss the content of the articles to see what students already know about commodities and to ensure better comprehension.

To synthesize project activities, we recommend some class discussion upon completion of Questions 1–8. You may then use Question 9 to heighten students' awareness of their own learning, and to encourage and guide students' reflections on their ePortfolios.

When surveyed, some students complained that the project was a bit long and time consuming. To reduce the workload, you can make Reading #2 (Question 4) optional, and assign it for extra credit. It is also important that you allocate two lab hours to go over the project with the students. In the first lab hour, you can initiate a class discussion around Question #2 and explain Question #5 about percentage increase and how to predict future prices based on that. In the second lab hour, guide students through Questions 6 and 7 which involve graphing with Excel. As mentioned earlier, feel free to select from Questions 6, 7 or 7d.

Activity Overview

In this project, students will engage in inquiry-based learning, collecting data about commodities and food commodity trading. They will also read two articles about the practices and devastating effects of food speculation, and do two exercises on function fitting using commodity prices. Three problems are provided (one for linear, one for quadratic and one for exponential). As the instructor, you will decide how many and which problems to assign. This lends flexibility to the project, as it can be introduced either after Lesson 12 (linear fitting), Lesson 24 (quadratic fitting) or Lesson 32 (exponential fitting).

- Have students consult the two given websites (http://www.investorwords.com, and http://www.indexmundi.com/commodities), to learn what commodities are.

- Before moving on to Reading #1, have students answer Questions 1 and 2. Question 2 is a discussion activity that will help to prepare students, in terms of vocabulary and concepts, for the readings and tasks that follow.

- Have students read Reading #1: "Food speculation: 'People die from hunger while banks make a killing on food'" by John Vidal, *The Guardian*. This article can be found at http://www.guardian.co.uk/global-development/2011/jan/23/food-speculation-banks-hunger-poverty. Have students answer Question 3 in writing so that you can check their understanding, and see that they can compare and add information to their evolving understanding of the deregulation of food commodities trading after they have done Reading #2.

- Have students read Reading #2: "Rampant Speculation Inflated Food Price Bubble" by Stephen Leahy, *IPS News*. The article can be found at http://ipsnews.net/news.asp?idnews=54274
- Have students answer Questions 4 to 7. Their answers to Question 4 will demonstrate their understanding of the concepts discussed in the article; Questions 5–7, including the Optional Extra Credit Question 7d., will demonstrate their ability to apply their mathematical skills.
- The essay writing task will require students to marshal evidence from the two readings and the mathematics in support of their opinions about the deregulation of food commodities trading. They should post this essay on their ePortfolios.
- Finally, the ePortfolio reflection will prompt students to think about their own level of political engagement, their own learning, and the ultimate usefulness of this project.

Materials and Resources

- Handout: Students are also expected to retrieve information from online sites such as: IndexMundi, "a data portal that gathers facts and statistics from multiple sources and turns them into easy to use visuals" (http://www.indexmundi.com/commodities), and InvestorWords.com, a site that provides definitions, videos and other information related to investing (http://www.investorwords.com).
- Reading #1: Vidal, John. (2011, January 23). "Food speculation: 'People die from hunger while banks make a killing on food.'" *The Guardian*. Retrieved March 2nd 2011 from http://www.guardian.co.uk/global-development/2011/jan/23/food-speculation-banks-hunger-poverty
- Reading #2: Leahy, S. Rampant Speculation Inflated Food Price Bubble. *IPS News.net*. Retrieved March 2, 2011 from http://ipsnews.net/news.asp?idnews=54274

Handout: What Are Commodities?

R. Jaafar and Y. Baishanski | College Algebra and Trigonometry – Business and Finance (MAT115)

Objectives

- To understand the definition of commodities
- To learn about the factors that affect commodity prices
- To understand how processes involving commodities can influence the lives of people around the world
- To determine relationships between various commodity prices
- To learn how to fit data, extract various quantities, and understand charts

Questions

1. a. Paraphrase in writing the definition of "commodity" as shown at http://www.investorwords.com.

   b. List the various categories of commodities displayed at http://www.indexmundi.com/commodities.

2. Group/Class Discussion
   a. What does "speculation" mean? How is it different from "investment"?

   b. What does "deregulation of global commodity markets" mean? Why do you think the U.S. would deregulate food commodity trading?

   c. What do the following words mean?
      – staples
      – hoarding
      – subsidise (Br.) (subsidize, Am.)
      – sub-prime mortgage crisis
      – pension fund
      – hedge fund

3. Answer the following questions about Reading #1, "Food speculation: 'People die from hunger while banks make a killing on food.'" in writing:

   a. What is hedging? Give an example.

   b. What is "deregulation of global commodity markets"? Why do you think the U.S. deregulated food commodity trading?

   c. How do experts at the UN explain the rise in food prices?

   d. What theory does the author believe is behind the rise in food prices?

   e. How did the speculation in food prices begin?

   f. Why did the price of chocolate peak recently?

4. Answer the following questions about Reading #2: "Rampant speculation inflated food price bubble."
   a. What is the meaning of "bubble" in this reading?
   b. The article illustrates "speculation on speculation" by examining how Farmer Brown's wheat futures contract can now be sold and resold, itself becoming a commodity. Can you foresee any potential problem(s) caused by such increasing speculation?
   c. Why did the U.S. deregulate food commodity trading? What was the result?
   d. Why did food commodity speculation become a "hot ticket" in 2008?
   e. After spikes in the price of food in 2008 caused deadly famine and riots around the world, the UN cited rising food prices as a top threat to global security. Why did food prices spike again in 2010?
   f. Why did multinational grain companies in the business of exporting wheat want Russia to *ban* wheat exports in 2010?
   g. According to GRAIN research, why weren't wheat exporters penalized for cancelling their export contracts with Egypt, Bangladesh, and other countries?

5. The following three graphs illustrate the 15-year price fluctuations in wheat, natural gas and poultry, respectively. Use the graphs to answer the questions below:

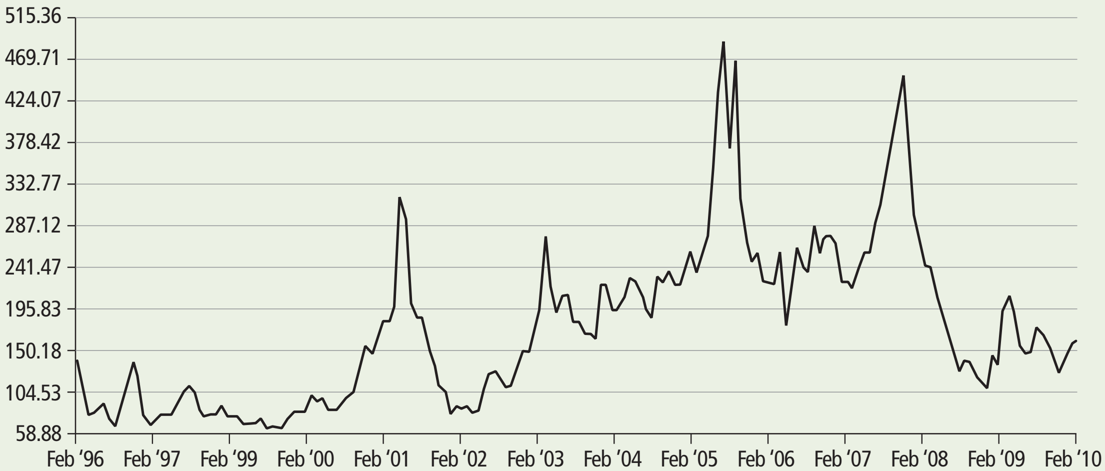
15-Year Price Fluctuation in Wheat

U.S. dollars per metric ton

Source: IndexMundi.com. (n.d.) Wheat Daily Price. Retrieved March 2, 2011 from http://www.indexmundi.com/commodities/?commodity=wheat&months=180

15-Year Price Fluctuation in Natural Gas

U.S. dollars per thousand cubic meters of gas



Source: IndexMundi.com. (n.d.) Natural Gas Monthly Price - US Dollars per thousand cubic meters of gas. Retrieved March 2, 2011 from http://www.indexmundi.com/commodities/?commodity=natural-gas&months=1800

15-Year Price Fluctuation in Poultry

U.S. cents per pound

Source: IndexMundi.com. (n.d.) Poultry (chicken) Daily Price. Retrieved March 2, 2011 from http://www.indexmundi.com/commodities/?commodity=chicken&months=180

a. Based on the graphs, which of the three commodities would you say is the most volatile? Which commodity would you say has experienced the greatest increase in volatility? Explain.

b. Estimate the price per pound of poultry (rounding to nearest cent) in February of 1996 and 2011 respectively. What was the average yearly rate of change in the price of poultry over this 15-year period? Based on this rate of change, how much will a pound of poultry cost in February 2012?

c. John argues that natural gas prices s*hould not be subject to regulation because they are relatively stable*: the price per thousand cubic meters only increased from approximately \$140 fifteen years ago to \$160 today. Compute the corresponding percent increase in price. Does the graph support his claim?

d. Judy argues that natural gas prices are at least as volatile as those of wheat, and thus that both natural gas and wheat prices *should be subject to regulation*. She says wheat prices went from a low of approximately \$160 per metric ton to a high of approximately \$440 over the last five years. Compute the corresponding percent increase in price.

e. Class Discussion: What's your position on the regulation of commodities? Do you agree with John or Judy? Are commodity prices stable or volatile? Should they be monitored and regulated by an independent body? Find information from these graphs or others at http://www.indexmundi.com/commodities to support your point of view. Take notes. You will need these notes again for Exercise 8.

6. **Exercise with Excel: Linear Fit**
The following table shows the average monthly price of cocoa beans, in U.S. dollars per metric ton, between March 2009 and December 2009.

Average monthly price of cocoa beans
U.S. dollars per metric ton

Mar 2009	2,493.98
Apr 2009	2,541.70
May 2009	2,554.60
Jun 2009	2,699.61
Jul 2009	2,805.48
Aug 2009	2,956.66
Sep 2009	3,149.51
Oct 2009	3,372.50
Nov 2009	3,379.33
Dec 2009	3,517.54

Source: IndexMundi.com. (n.d.) Cocoa Beans Monthly Price – US Dollars per Metric Ton. Retrieved March 2, 2011 from http://www.indexmundi.com/commodities/?commodity=cocoa-beans&months=180

a. Using Excel and starting with March 2009 as month #0, graph the price of cocoa beans as a function of the number of each month (March 2009 =0, April 2009 =1, etc.).

b. Fit the data to a linear function. Write the equation that the data fits to. Find the slope.

c. If the trend had continued, what would the price of cocoa beans have been in February 2010?

Exercise with Excel: Quadratic Fit

The following table shows the average monthly price of coconut oil, in U.S. dollars per metric ton, between August 2009 and January 2011.

Average monthly price of coconut oil
U.S. dollars per metric ton

Aug 2009	747.00
Sep 2009	701.00
Oct 2009	706.00
Nov 2009	729.00
Dec 2009	768.00
Jan 2010	784.00
Feb 2010	798.00
Mar 2010	921.00
Apr 2010	939.00
May 2010	932.00
Jun 2010	993.00
Jul 2010	1,031.00
Aug 2010	1,170.00
Sep 2010	1,275.00
Oct 2010	1,412.00
Nov 2010	1,521.30
Dec 2010	1,715.00
Jan 2011	2,063.00

Source: IndexMundi.com. (n.d.) Coconut Oil Monthly Price – US Dollars per Metric Ton. Retrieved March 2, 2011 from http://www.indexmundi.com/commodities/?commodity=coconut-oil&months=180

a) Using Excel and starting with August 2009 as month #0, graph the price of coconut oil as a function of the number of each month (August 2009=0, September 2009=1, etc.)

b) Fit the data to a quadratic function (on Excel, use polynomial of order 2). Write the resulting equation.

c) If the trend had continued, what would the price of coconut oil have been in July 2011?

7d. **Extra Credit. Exponential fit**

Commodities are traded daily, their prices changing by milliseconds, just like the prices of stocks in the stock market. Commodities fall into several categories: energy, beverages, cereals, fruits, meat, sugar, vegetable oils, etc. Commodities include many food categories, prompting debate as to whether the prices of commodities should be allowed to fluctuate without control. When the prices of such commodities as wheat or sugar increase dramatically, many in developing countries are left without access to food. The following table shows the average monthly price of cocoa beans, in U.S. dollars per metric ton, between June 2001 and October 2002.

Average monthly price of cocoa beans
U.S. dollars per metric ton

Jun 2001	973.29
Jul 2001	965.32
Aug 2001	1,032.48
Sep 2001	1,026.20
Oct 2001	1,084.86
Nov 2001	1,231.55
Dec 2001	1,337.43
Jan 2002	1,385.93
Feb 2002	1,490.39
Mar 2002	1,592.03
Apr 2002	1,568.15
May 2002	1,604.70
Jun 2002	1,656.46
Jul 2002	1,872.00
Aug 2002	1,959.27
Sep 2002	2,167.41
Oct 2002	2,201.50

Source: IndexMundi.com. (n.d.) Cocoa Beans Monthly Price – US Dollars per Metric Ton. Retrieved March 2, 2011 from http://www.indexmundi.com/commodities/?commodity=cocoa-beans&months=180

a. Using Excel and starting with June 2001 as month #0, graph the price of cocoa beans as a function of the number of each month (June 2001 =0, July 2001 =1, etc.)

b. Fit the data to an exponential function. Write the resulting equation.

c. If the trend had continued, what would the price of cocoa beans have been in February 2003?

7. **Writing Task:**
   This project has shown you the results of the deregulation of food commodities trading. Do you think the trading of food commodities should be monitored and regulated by an independent agency, or do you think deregulation is preferable? Write an essay expressing your opinion. To strengthen your argument, refer to the ideas exchanged during the class discussion (see Question 5e), to the readings, and to the graphs in Exercise 4 or other graphs at http://www.indexmundi.com/commodities. Support your point of view with specific details.

8. **ePortfolio Reflection**

   a. Has this activity affected your social concerns, political awareness or engagement in any way? If so, how? Will your own behavior be affected by this class activity? If so, how?

   b. Before you graphed the tabled data in questions 6 and 7, what would you have predicted as future prices of coconut oil and cocoa beans?

   c. What do you see in the graphs that you didn't see in the tabled data in questions 6 and 7?

   d. Why do you suppose this project asked you to identify equations of graphs? Why is it useful to recognize equations from a given graph?

   e. Why might it be useful to do the reverse—to be able to graph a given equation?

Reading #1: Food Speculation: "People die from hunger while banks make a killing on food"

R. Jaafar and Y. Baishanski | College Algebra and Trigonometry – Business and Finance (MAT115)

Source: John Vidal (2011, January 23rd). Food Speculation: 'People die from hunger while banks make a killing on food'. *Guardian*. Retrieved March 2nd 2011 from http://www.guardian.co.uk/global-development/2011/jan/23/food-speculation-banks-hunger-poverty

Illustration: Katie Edwards

It's not just bad harvests and climate change – it's also speculators that are behind record prices. And it's the planet's poorest who pay

Just under three years ago, people in the village of Gumbi in western Malawi went unexpectedly hungry. Not like Europeans do if they miss a meal or two, but that deep, gnawing hunger that prevents sleep and dulls the senses when there has been no food for weeks.

Oddly, there had been no drought, the usual cause of malnutrition and hunger in southern Africa, and there was plenty of food in the markets. For no obvious reason the price of staple foods such as maize and rice nearly doubled in a few months. Unusually, too, there was no evidence that the local merchants were hoarding food. It was the same story in 100 other developing countries. There were food riots in more than 20 countries and governments had to ban food exports and subsidise staples heavily.

The explanation offered by the UN and food experts was that a "perfect storm" of natural and human factors had combined to hyper-inflate prices. US farmers, UN agencies said, had taken millions of acres of land out of production to grow biofuels for vehicles, oil and fertiliser prices had risen steeply, the Chinese were shifting to meat-eating from a vegetarian diet, and climate-change linked droughts were affecting major crop-growing areas. The UN said that an extra 75m people became malnourished because of the price rises.

But a new theory is emerging among traders and economists. The same banks, hedge funds and financiers

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But a new theory is emerging among traders and economists. The same banks, hedge funds and financiers whose speculation on the global money markets caused the sub-prime mortgage crisis are thought to be causing food prices to yo-yo and inflate. The charge against them is that by taking advantage of the deregulation of global commodity markets they are making billions from speculating on food and causing misery around the world.

As food prices soar again to beyond 2008 levels, it becomes clear that everyone is now being affected. Food prices are now rising by up to 10% a year in Britain and Europe. What is more, says the UN, prices can be expected to rise at least 40% in the next decade.

There has always been modest, even welcome, speculation in food prices and it traditionally worked like this. Farmer X protected himself against climatic or other risks by "hedging", or agreeing to sell his crop in advance of the harvest to Trader Y. This guaranteed him a price, and allowed him to plan ahead and invest further, and it allowed Trader Y to profit, too. In a bad year, Farmer X got a good return but in a good year Trader Y did better.

When this process of "hedging" was tightly regulated, it worked well enough. The price of real food on the real world market was still set by the real forces of supply and demand.

But all that changed in the mid-1990s. Then, following heavy lobbying by banks, hedge funds and free market politicians in the US and Britain, the regulations on commodity markets were steadily abolished. Contracts to buy and sell foods were turned into "derivatives" that could be bought and sold among traders who had nothing to do with agriculture. In effect a new, unreal market in "food speculation" was born. Cocoa, fruit juices, sugar, staples, meat and coffee are all now global commodities, along with oil, gold and metals. Then in 2006 came the US sub-prime disaster and banks and traders stampeded to move billions of dollars in pension funds and equities into safe commodities, and especially foods.

"We first became aware of this [food speculation] in 2006. It didn't seem like a big factor then. But in 2007/8 it really spiked up," said Mike Masters, fund manager at Masters Capital Management, who testified to the US Senate in 2008 that speculation was driving up global food prices. "When you looked at the flows there was strong evidence. I know a lot of traders and they confirmed what was happening. Most of the business is now speculation – I would say 70-80%."

Masters says the markets are now heavily distorted by investment banks: "Let's say news comes about bad crops and rain somewhere. Normally the price would rise about $1 [a bushel]. [But] when you have a 70-80% speculative market it goes up $2-3 to account for the extra costs. It adds to the volatility. It will end badly as all Wall Street fads do. It's going to blow up."

The speculative food market is truly vast, agrees Hilda Ochoa-Brillembourg, president of the Strategic Investment Group in New York. She estimates speculative demand for commodity futures has increased since 2008 by 40-80% in agricultural futures.

But the speculation is not just in staple foods. Last year, London hedge fund Armajaro bought 240,000 tonnes, or more than 7%, of the world's stocks of cocoa beans, helping to drive chocolate to its highest price in 33 years. Meanwhile, the price of coffee shot up 20% in just three days as a direct result of hedge funds betting on the price of coffee falling.

Olivier de Schutter, UN rapporteur on the right to food, is in no doubt that speculators are behind the surging prices. "Prices of wheat, maize and rice have increased very significantly but this is not linked to low stock levels or harvests, but rather to traders reacting to information and speculating on the markets," he says.

"People die from hunger while the banks make a killing from betting on food," says Deborah Doane, director of the World Development Movement in London.

The UN Food and Agriculture Organisation remains diplomatically non-committal,saying, in June, that: "Apart from actual changes in supply and demand of some commodities, the upward swing might also have been amplified by speculation in organised future markets."

The UN is backed by Ann Berg, one of the world's most experienced futures traders. She argues that differentiating between commodities futures markets and commodity-related investments in agriculture is impossible.

"There is no way of knowing exactly [what is happening]. We had the housing bubble and the credit default. The commodities market is another lucrative playing field [where] traders take a fee. It's a sensitive issue. [Some] countries buy direct from the markets. As a friend of mine says: 'What for a poor man is a crust, for a rich man is a securitised asset class.'"

Reading #2: Rampant Speculation Inflated Food Price Bubble

R. Jaafar and Y. Baishanski | College Algebra and Trigonometry – Business and Finance (MAT115)

Source: Leahy, S. (2011, January 28th). Rampant speculation inflated food price bubble. *IPS*. Retrieved March 2, 2011 from http://ipsnews.net/news.asp?idnews=54274

UXBRIDGE, Canada, Jan 28, 2011 (IPS) – Billions of dollars are being made by investors in a speculative "food bubble" that's created record food prices, starving millions and destabilising countries, experts now conclude.

Wall Street investment firms and banks, along with their kin in London and Europe, were responsible for the technology dot-com bubble, the stock market bubble, and the recent U.S. and UK housing bubbles. They extracted enormous profits and their bonuses before the inevitable collapse of each.

Now they've turned to basic commodities. The result? At a time when there has been no significant change in the global food supply or in food demand, the average cost of buying food shot up 32 percent from June to December 2010, according to the U.N. Food and Agriculture Organisation (FAO).

Nothing but price speculation can explain wheat prices jumping 70 percent from June to December last year when global wheat stocks were stable, experts say.

"There is no food shortage in the world. Food is simply priced out of the reach of the world's poorest people," said Robert Fox of Oxfam Canada in reference to the estimated one billion people who go hungry.

"Hunger is not a food production problem. It is an income problem," Fox told IPS.

The conditions that created the 2007-08 price hike and food riots have not changed, he said. It is no surprise to see record-high food prices and riots again in Egypt, Algeria, Jordan and elsewhere.

Weather used to be the big determinant of food prices, but not anymore. Trillions of dollars have been pumped into food commodities markets in the last few years thanks to deregulation of commodities trading in the U.S., reports Olivier De Schutter, the United Nations Special Rapporteur on the Right to Food.

In an analysis of the food price crisis of 2007-08, De Schutter documents how the U.S. government passed legislation in 2000 deregulating the food commodity markets and for the first time permitted speculation on speculation.

Here's how it used to work. In January, Farmer Brown would sign a contract to sell his 2011 future crop to a grain trader like industry giant Cargill for 100 dollars a tonne. In the fall, Cargill would then sell Farmer Brown's grain at whatever price they could get to a bakery or feedlot company for cattle. These "futures" contracts insulated both the farmer and the grain trader from wild price fluctuations.

Now, after the passage of the U.S. Commodity Futures Modernisation Act in 2000, Cargill could sell Farmer's Brown "futures" contract to an investment bank on Wall Street for 120 dollars a tonne, who could in turn sell it to a European investment company for 150 dollars a tonne and then sell it to a U.S. public pension fund for 175 dollars a tonne and so on. Add in some complex financial instruments like 'derivatives', 'index funds', 'hedges', and 'swaps', and food become part of yet another highly-profitable speculative bubble.

A deeply-flawed global financial system was largely responsible for the 2007–08 food crisis, concluded De Schutter in a September 2010 briefing note.

"Speculators increasingly entered the market in order to profit from short-term changes in price," wrote agricultural economist Jayati Ghosh, in a more recent analysis of the 2007-08 food price spike.

With the pending implosion of "the U.S. housing finance market, large investors, especially institutional investors such as hedge funds and pension funds and even banks, searched for other avenues of investment to find new sources of profit," said Ghosh, a professor at Jawaharlal Nehru University in New Delhi in the Journal of Agrarian Change.

Food commodity speculation became the "hot ticket" and unregulated trading zoomed from 0.77 trillion dollars in 2002 to seven trillion dollars in 2007. Food prices shot upwards until the speculators took their profits in the first half of 2008 to cover their losses in the U.S. housing and other markets, she concluded. By the fall of 2008 prices stabilised but remained substantially higher than they were before the speculative bubble.

"At the end of December 2008, the FAO estimated that 33 countries were experiencing severe or moderate food crises, with conditions in at least 17 countries worse compared to October 2008," Ghosh said.

And 2008 was a year of record grain production internationally.

Now there is a new and bigger food price bubble that began midway through 2010. It's no surprise since nothing was done to change the conditions, Ghosh wrote. Regulations that could prevent or at least limit such speculative financial activity are not in place. The 2010–11 food price bubble is blamed on last summer's Russian drought and increased consumption by India and China. However, FAO figures clearly show grain consumption by those latter two countries has actually fallen, mainly because many simply can't afford to buy as much grain, Ghosh told IPS in an email interview. In India, there has also been "diet shifts to more vegetables and dairy products", she said.

The Russian drought simply sparked this latest speculative bubble. Russia did lose 33 percent of its wheat harvest, but it had plenty of wheat stocks on hand to make up the difference. Instead of using those stocks, the Russian government was persuaded by multinational grain companies to ban wheat exports.

That enabled those companies to break their low-price export contracts with Egypt, Bangladesh and other countries and sell their grain on the inflated domestic wheat market, says Devlin Kuyek of GRAIN, a small international non-profit organisation that works to support small farmers.

"Big companies now control much of the Russian agriculture," Kuyek said in an interview.

GRAIN has documented how foreign and local investors have set up huge, vertically integrated "agro-holdings", particularly in the southern grain belt where they now control 40–50 percent of total grain production.

Russia is a major wheat exporter and Swiss-owned Glencore exports most of Russia's wheat. However, GRAIN research reveals that Glencore lobbied to get an export ban allowing the company to cancel its low-price contracts without penalty.

To ease the 'sting' of the ban, Russia also promised one billion dollars in low-interest loans and subsidies for grain producers.

"Countries like Egypt really got screwed and the grain traders made a killing," Kuyek said.

Should You Take Out That Loan? A Lesson on Interest Rates and Debt

Reem Jaafar
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

The purpose of this project is to help students understand the concept of interest rates; that is, how interest accumulates over time, and the variables on which interest rates depend. This is also a lesson on linear modeling, fitting data points, and extracting various quantities from the linear model. Linear functions are encountered from Lessons 2 through 13 in the College Algebra and Trigonometry (MAT115) syllabus.

Math Topic
Graphing linear equations, equation of a straight line, applications of linear functions

Purpose
Review, synthesis, reflection, and analysis

When to Introduce
Anytime after lesson 18 (around week 5)

Activity Time Frame
Two–three weeks

Through this activity, students are expected to:

- Read articles about car loans and understand the components of a loan;
- Read articles about student loans and understand the long-term ramifications of the accumulation of huge debt;
- Understand the bureaucracy behind student loans and engage in reflective writing on how the industry can be fixed;
- Plot a set of data in Excel, fit the points to a linear function, find the slope and write the equation of a linear function; and,
- Extract various quantities from a set of data fit to a straight line.

Reflection

The average credit card debt per household is: $15,788.

(Woolsey, B. and Schulz, M. (2011). Credit card statistics, industry facts, debt statistics. *CreditCards.com CreditCards.com.* Retrieved Sept. 4, 2011 from http://www.creditcards.com/credit-card-news/credit-card-industry-facts-personal-debt-statistics-1276.php#ixzz1DIrEsXln .)

It is critical that students understand the impact of debt on their personal and financial lives. Students will enjoy learning about debt when the topic is presented through engaging, real life examples. To build student motivation for the project, you may want to begin by asking who among them owns a car and whether those students were aware of and understood the financing options available to them when they purchased the car.

In Part II on student loans, Activities 8, 9 and 10 are self-explanatory, but they work best if you initiate a class discussion about student loans beforehand. For an exciting way to start the activity, follow the directions in Step 1 and ask students to interpret the title of Reading #2, predict what it's about, and discuss their opinions in general. After they have finished Reading #2, they can re-discuss their opinions based on the specific stories of the two couples.

Students respond well to the content of this project. They may, however, complain about its length. It is therefore best to allow them an extra week to complete and submit their work. This project should help students read, analyze information and think critically. I also hope they will retain a few facts from their reading that will help them extend their understanding of the relationship between interest rates and credit card debt, and encourage them to engage in sound financial behavior.

Activity Overview

This project can be introduced at any time after Lesson 18, or around week 5. Since the project has two parts (Part I, related to car loans, Part II, to student loans), you should spend about two lab hours on the activity.

The activity relies on getting data from online sites. The sites are trustworthy but students initially need to be shown how to copy and paste one row of data into each table. Time permitting, have students complete the table while in the lab to make sure they are on the right track.

During the first lab hour, guide students through Questions 1 to 5. Have them choose their dream cars. To fill in the various tables of Questions 4 and 5, students use an online calculator to estimate their payments. This helps them see the effect of interest rates on their monthly payments. Once they realize that the total amount paid to the bank far exceeds the amount borrowed, students will also see the benefits of increasing their monthly payments, even by modest amounts.

In the next lab hour, wrap up the section on car loans. Have students complete question 6, in which they will use Excel to plot several data points related to the problem of financing a car.

You may need to spend about 15 minutes during the lab hour showing the students how to plot data in Excel. In Question 7, give students guidelines as to what you expect them to write in their letter to a friend planning to buy a car.

In Part II, students read several articles on student loans which reveal some alarming facts about the student loan industry. They answer questions about the articles and complete reflective writing activities for each article.

It is preferable to have students upload the entire project into their ePortfolios, but if time is lacking, have them at least upload the writing task in Activity 10.

Materials and Resources:

- Handout #1
- Handout #2
- Reading#1: Page Deaton, J. (2008, Aug 15). How to finance a car and get a car loan. *U.S. News and World Report*. Retrieved Feb.14, 2011 from http://usnews.rankingsandreviews.com/cars-trucks/How-to-Finance-a-Car
- Reading #2: Lieber, R. (2010, September 3). How debt can destroy a budding relationship. *New York Times*. Retrieved February 14, 2011 from http://www.nytimes.com/2010/09/04/your-money/04money.html

- Reading #3: Collins, G. (2009, May 27). *When Sallie Met Barack. New York Times.* Retrieved Feb. 14, 2011 from http://www.nytimes.com/2009/05/28/opinion/28collins.html
- Students are also expected to get some information from online sites such as Edmunds.com, a website with information about the automotive industry and car prices (http://www.Edmunds.com)and Bankrate.com (http://www.bankrate.com).

Handout #1: Financing the American Dream or Living a Financial Nightmare?

R. Jaafar | College Algebra and Trigonometry – Business and Finance (MAT115)

Objectives

This handout is based on Reading #1: "How to finance a car and get a car loan," by Jamie Page Deaton, published in *U.S. News and World Report*. The article can be found at http://usnews.rankingsandreviews.com/cars-trucks/How-to-Finance-a-Car/

By reading this article and answering Questions 1–7, you will learn:

- basic facts about financing and securing loans;
- how interest rates can affect monthly payments on loans; and,
- how monthly payments depend on the term of the loan and on the interest rate.

Questions

1. Go to www.edmunds.com
   Search the car inventory and choose the car of your dreams. Write down the MSRP (Manufacturer Suggested Retail Price) of your chosen car, and briefly explain why you chose this particular car.
2. Discussion: What is a car loan? What do you already know about the conditions of car loans?
3. Write your answers to the following questions regarding Reading #1. Then discuss your answers as a class.
   a. When you pay back a loan, what does each of your payments include?
   b. What does "loan term" mean?
   c. When you take out a loan to buy a car, who owns the car? When do you take ownership of the car?
   d. What happens if you miss a loan payment?
   e. Does everyone get the same interest rate? What factors determine your interest rate?
   f. What can you do to guard against dealer tricks?

4. $$ Your Financing Options $$
   In this section, you will have to go online to determine the interest rate that applies when you finance your car. Let's say you are unable to make a down payment on the car and you have to finance the full amount.
   - Get the MSRP of your car.
   - Go to http://www.bankrate.com and click on the Auto link.
   - Click on "Find an Auto Loan Rate" and select the purchase option.
   - Select your city and state.
   - Ignore the lender list under the search results and click instead on the "Calculator" button.
   - At this point you will have the "Auto Calculator" on the screen.
     Use the Calculator to determine your monthly payment, based on a 10% interest rate, for terms of 60 months (5years), 48 months (4 years), 36 months (3 years), 24 months (2 years), or 12 months (1 year). Fill in Table 1 below.

Table 1: Monthly payments and interest payments based on 10% interest rate for various loan terms

	Monthly payment (at 10% interest rate)	Total interest paid by end of loan term	Total payment by end of loan term = MSRP +Total interest paid
60 months			
48 months			
36 months			
24 months			
12 months			

a. Compare the cost of financing the vehicle over 3 years (36 months) and over 5 years (60 months). How much money would you save in interest if you were to finance the vehicle over 3 years?

b. Mr. Smith just got his bonus and decided to pay for his car outright (in cash). How much money will he save in interest by paying outright as opposed to financing his car over 5 years?

5. A Lower Interest Rate
   As you know from your reading of the *U.S. News and World Report* article (Reading #1), the interest rate on a loan depends on your credit score. Suppose a friend of yours has a higher credit score and ends up getting a 6% interest rate on the car that you want to purchase. How much less would your friend pay each month at 6% than you would pay at 10%? Answer by filling in Table 2 below.

Table 2: Monthly Savings at 6% interest rate and various loan terms

	Monthly payment at 6% interest rate	Monthly payment at 10% interest rate	Monthly savings
60 month			
48 month			
36 month			
24 month			
12 month			

6. Exercise with Excel
   Suppose you decide to buy a new car for $30,000. Since you have no money for a down payment, you decide to take out a loan for the full amount, even though you know this will cost you extra in interest payments. Unfortunately, the interest rate is pretty high, at 10%. The dealer offers several financing options through a local bank: financing the car over a 12-month, 24-month, 36-month, 48-month and 60-month period.

   The table below shows the total interest you will have paid by the end of your loan's term.

Total Interest Paid (in USD) by Term's End

Term of Loan (# of months)	Total Interest Paid by Term's End (in USD)
12 months	$ 1,649.72
24 months	$3,224.35
36 months	$4,848.56
48 months	$6,522.12
60 months	$8,244.68

Source: http://www.bankrate.com

   a. Using Excel, make a scatter plot of the total interest paid versus the term of the loan. Find the linear function that represents the total interest paid as a function of the term of the loan.

   b. Assuming you financed the car, how much would you have paid in interest 30 months after purchasing the car? If the dealer were to offer you financing over 7 years, what would be the total interest paid after 7 years?

7) Your friend John is planning to finance a car. He is unsure about his budget, but thinks he can afford a $15,000 car. He has only $2,000 to put down and he earns about $1,500 a month after taxes. John contacts you for advice. What advice would you give him? Please write a 100–200 word letter to John, advising him on how much he should spend on a car, what interest rate he should try to get and how much he can afford in monthly payments.

Handout #2: Dreams of an Education

R. Jaafar | College Algebra and Trigonometry – Business and Finance (MAT115)

Introduction

As many of you well know, it is common for students to borrow money to finance their education. Many students borrow huge amounts of money and then struggle to repay their loans after graduation. One crucial reality is that you cannot default on a student loan. Student loans must be paid back, no matter what. In this part of the project, you will learn about the consequences of debt due to student loans.

Directions

Step 1 Class Discussion: Reading #2 is entitled "How debt can destroy a budding relationship." (Lieber, R. (2010, September 3). How debt can destroy a budding relationship. *New York Times.* Retrieved February 14, 2011 from http://www.nytimes.com/2010/09/04/your-money/04money.html)

What does this title mean? Predict what you think this article is about.

Step 2 Now read Reading #2 and answer the questions below in writing.

a. How much did Alison think she owed on her student loan and how much did the debt turn out to be? Why do you think her debt turned out to be higher than she thought?

b. Was Alison's fiancé justified in his reaction to her debt?

c. How much does Ms. Tidwell owe on her student loan? What are her chances of repaying it?

d. Do you think that Mr. Kogler should still marry Ms. Tidwell?

e. Are these two stories about student loan debt different? How?

f. Writing Task: Do you think that the astronomical cost of education in the United States is having a negative effect on marriage? Write a 200-word essay and use the examples provided in Reading #2 to support your argument.

Step 3 Reading #3. "When Sallie Met Barack," a *New York Times* article by Gail Collins. http://www.nytimes.com/2009/05/28/opinion/28collins.html?adxnnl=1&adxnnlx=1313772044-//u5u65XUbA0XLSBhfsuYg, or http://www.nytimes.com/2009/05/28/opinion/28collins.html

After reading the article, answer the questions below in writing.

a Why is it almost impossible for students to work their way through college today?

b. What was the total amount borrowed in private student loans in 2008?

c. What happened to Travis and Stephanie Gay?

d. Name one deceptive marketing practice used by student loan providers

Step 4 Group Work and Class Discussion: Work with your group to decide what the author's attitude is toward the way the federally guaranteed student loan system works. How do you know? Find examples in the reading that reveal Gail Collins' opinion. Then share your ideas with the class.

Step 5 ePortfolio Writing Task. Write a well-organized essay that clearly states your opinion of the federally guaranteed student loan system. What do you personally think about the way the student loan system operates? Give examples to support your opinion. Your examples should address the three questions listed below:

a. Why doesn't the government lend money to students directly through the federally guaranteed loan system? What does "Sallie Mae" refers to?

b. Who benefits from this federally guaranteed student loan system? Who pays for it in the end?

c. Why is Senator Nelson of Nebraska against a change in the student loan system?

You may conclude your essay by addressing this question: If you had the power to change the student loan system, what would you do?

Reading #1: How to Finance a Car and Get a Car Loan

R. Jaafar | College Algebra and Trigonometry – Business and Finance (MAT115)

Source: Page Deaton, J. (2008, Aug 15). How to finance a car and get a car loan. *U.S. News and World Report*. Retrieved Feb.14, 2011 from http://usnews.rankingsandreviews.com/cars-trucks/How-to-Finance-a-Car

Let's be honest: most people aren't thinking about buying a new car now. The Great Recession has put new cars out of most people's minds. But, if you really need a new car, you can get some great discounts and incentives. With the credit market still tight, the problem most people have is getting the financing to take advantage of the deals available.

Car financing is tricky even when the credit market is good. Now that the credit market is tight, it's back to basics for buyers and lenders. Check out the car financing basics covered below to make sure you get the best car loan for your next vehicle.

The Basics of Car Loans

Getting a car loan simply means borrowing money to pay for it. Borrowing money probably isn't new to you -- everyone's bummed $10 from friends. When you borrow from a lender, the amount you borrow is called the loan principle. Though the basic idea behind borrowing money for a car is the same, when it comes time to pay the loan back, things get a little complicated.

Unless your friends don't like you much, they're not going to charge you interest on money you borrow. But professional lenders will. A bank isn't your friend and doesn't lend money out of the goodness of its heart. It needs a financial incentive. That's what interest provides for the lender: a financial incentive to lend money.

When you take out a loan for a car, it'll come with an interest rate -- a certain percentage of a loan that you must pay back in addition to the original loan amount. So, if you borrow $20,000 for a car at a 5 percent interest rate, you're going to end up paying the bank $21,000 over the life of the loan -- that's the principle, plus the interest.

The Car Loan Term

The life of the loan, or loan term, simply refers to the amount of time you have to pay the lender back. If you sign up for a five-year term, in five years you'll pay the money back and will own the car free and clear. What the loan term doesn't mean is that five years from now you'll have to come up with all of the money. The vast majority of auto loans are repaid in monthly installments. You send the lender a set amount each month and slowly pay off the loan.

Most people think that when you finance a car, the finance company lends you the money and the car is yours. That's a simple way of looking at it. In reality, however, the lender is buying the car and letting you use it. The lender technically owns the car, though you agree to be responsible for it. In fact, you won't have the title to the car until you make your last loan payment. Miss loan payments and the lender repossess the car. Each payment you make buys you a little more of the car, but you don't fully own it until the loan is paid off.

Now that you know the basics, you're probably wondering how people can screw up financing a car. Believe it or not, there are plenty of ways.

Your Credit Score

All interest rates are not created equal. Some people get charged more interest, and some get charged less. Obviously, you want to get charged less. The interest rate lenders charge is based largely on your credit score -- a number that's assigned to you based on how much other debt you have and how good you've been about paying bills on time. Lenders use the score to assess how likely you are to pay them back. If your score is low, they'll think you're not likely to repay the auto loan and charge you more money to cover that risk.

Young people often have lower credit scores than older people, even if they've been good about staying out of debt and paying their bills. That's because young people don't have long credit histories, which makes it difficult for lenders to tell how much of a risk they are. As a result, people without long credit histories can be charged higher interest rates too.

You should know what your credit score is and do your best to make sure it's high. For a small fee, you can get it through Equifax, Experian or TransUnion. If your score is not as high as you'd like, paying off old bills (like credit card debt) and paying all bills on time (the full balance, not just the minimum due) for six to nine months should bring your score up and interest rate down.

Apply, Apply, Apply

You wouldn't just apply to one job or one college, so you shouldn't apply to just one lender for a car loan. Contact your bank, local credit unions and other lenders to find out what they're offering. You'll have to fill out loan applications, which will ask for your employment history, income, expenses and debts. Do not be tempted to exaggerate your income or misstate your expenses. Everything you fill out on a loan application will be verified and lying will get you into serious trouble. The lender will pull your credit history and credit score and make you a loan offer based on that information.

Take some time to go over all the offers. Don't just look at the interest rates -- avoid offers that charge you a lot of fees. Also, watch out for loans that have a prepayment penalty; that's a charge that you'll owe if you pay the loan off early. Paying the loan off early may not be something you'll be able to do, but if your long-lost Aunt Maybel dies and leaves you a fortune, paying it off could save you a lot of money -- and you don't want to pay extra to do it.

Don't be Dejected about Getting Rejected

Don't feel too badly if your loan application is rejected. It's probably a good thing. A rejected loan application means the lender didn't think you'd be able to pay the money back. As hard as that is, that lender just saved you from getting into debt over your head. Try finding a less expensive car to buy, or saving up more money.

Show Up with Financing

Most car buyers assume that the car dealership always has the best financing deals. That's not always the case. While you should certainly consider the loan the dealership offers, it's a good idea to have an approved loan application from a bank or credit union when you go to the dealership. That way, you'll know if the dealer is offering you a good financing deal, and you'll have an alternative if they're not.

Having financing all ready also means you'll be protected from some dealer tricks. Some dealers will give you a great price on a car, but will charge you a higher interest rate on the loan, which will cost you more money in the long run. With financing in hand, you can focus on the price of the car.

Reading #2: How Debt Can Destroy a Budding Relationship

R. Jaafar | College Algebra and Trigonometry – Business and Finance (MAT115)

Source: Lieber R. (2010, September 3rd). How Debt Can Destroy a Budding Relationship. Retrieved February 14th, 2011 from http://www.nytimes.com/2010/09/04/your-money/04money.htm

Nobody likes unpleasant surprises, but when Allison Brooke Eastman's fiancé found out four months ago just how high her student loan debt was, he had a particularly strong reaction: he broke off the engagement within three days.

Ms. Eastman said she had told him early on in their relationship that she had over $100,000 of debt. But, she said, even she didn't know what the true balance was; like a car buyer who focuses on only the monthly payment, she wrote 12 checks a year for about $1,100 each, the minimum possible. She didn't focus on the bottom line, she said, because it was so profoundly depressing.

But as the couple got closer to their wedding day, she took out all the paperwork and it became clear that her total debt was actually about $170,000. "He accused me of lying," said Ms. Eastman, 31, a San Francisco X-ray technician and part-time photographer who had run up much of the balance studying for a bachelor's degree in photography. "But if I was lying, I was lying to myself, not to him. I didn't really want to know the full amount."

At a time when even people with no graduate degrees, like Ms. Eastman, often end up six figures in the hole and people getting married for the second time have loads of debt from their earlier lives, it should come as no surprise that debt can bust up engagements. Even when couples disclose their debt in detail, it poses a series of challenges.

When, exactly, are you supposed to reveal a debt of this size during the courtship? Earlier than you'd disclose, say, a chronic illness?

Even if disclosure doesn't render you unmarriageable, tricky questions linger. If one person brings a huge debt to a relationship, who is ultimately responsible for making good on the obligation? And if it's $170,000, isn't the more solvent partner going to resent that debt over time no matter how early the disclosure comes? After all, it will profoundly affect every financial decision, from buying a home to how many children to have.

These were the questions that weighed on Kerrie Tidwell. A third-year student at the Medical College of Georgia and an aspiring emergency room doctor, she doesn't worry so much about her ability to pay back her loans.

Ms. Tidwell, 26, is involved in a serious relationship with Stefan Kogler, an architect who is a native of Austria and living in Vienna. To Europeans, who often pay little or nothing toward their university studies, the idea of going deeply into debt to get educated is, well, foreign.

Ms. Tidwell feels no guilt about the $250,000 in debt she will probably run up, including some from a master's degree program she completed in London, where she and Mr. Kogler met. "I didn't acquire it because I go out and shop a lot," she said. "It's because I'm doing something that I'll love for the rest of my life."

Still, if she and Mr. Kogler are going to move in together and get engaged, she wants their financial arrangements to be clear and fair. But how do you define fair when you're bringing a quarter of a million dollars in debt to a relationship?

Mr. Kogler, 30, said he's not so worried about it. "In the long run, it will equal out," he said. "In the short run, you have to support each other, and I will support her as much as I can."

His stoicism is admirable. It's all the more so, given that if he moves to the United States permanently, he'll probably lose the chance to run his family's business in Austria. Supporting Ms. Tidwell as she begins to pay back her loans also means he doesn't have the freedom to, say, make a career change that involves a big pay cut. "I know he has his own dreams, and they will require money," Ms. Tidwell said. "Will my debt take away from that?"

Lisa J. B. Peterson, a financial planner with Lantern Financial in Boston, specializes in counseling young couples and has heard this story before. About half the people she sees are both bringing significant debt to the relationship, and about a quarter of the others have one person who has a pile of student loans.

When I told her about Ms. Tidwell and Mr. Kogler, one of her first suggestions was for them to make sure that Mr. Kogler did not have to make all the compromises when they prepared a joint household budget.

"They can make some kind of sacrifice so that a goal of his is achieved, too," she said.

Then there's the question of how to plan for the unknowns. "What would happen if I got hurt and couldn't practice or got sued for malpractice?" Ms. Tidwell asked.

While insurance (which is itself expensive, alas) can reduce this anxiety, it can't cover the desire to stay home with children. Ms. Tidwell is resolute about having children and working full time, but Sheila G. Riesel, a matrimonial lawyer and partner with Blank Rome in Manhattan, said Ms. Tidwell ought to consider potential extreme circumstances as well. "It could happen that she wants to be a stay-at-home spouse for a while. What if she has triplets?" Ms. Riesel asked. "All of this is worthy of discussion."

The problem is, most couples never get this far in the premarriage money talks. One advantage to prenuptial agreements is that they force the issue, even if it does turn the talks into a negotiation. "At least half the time, people are shocked at what the other person's attitude is," said Susan Reach Winters, a matrimonial lawyer with Budd Larner in Short Hills, N.J. "You ask how they'd handle it if someone wanted to stay home after having a baby, and at the same time they give completely different answers."

Legally, it is likely that any leftover debt that Ms. Tidwell brought to a marriage would remain hers alone after a divorce. But Ms. Reach Winters said that if she were representing someone like Ms. Tidwell's boyfriend in a divorce, she would argue that he deserved a sort of refund for everything he paid toward household expenses even if Ms. Tidwell were making the loan payments out of her salary alone. Whether a state's laws back up this argument may be beside the point; any lawyer can use it as a battering ram in settlement negotiations.

Ms. Riesel also said couples needed to be wary of states like New York, where an advanced degree acquired during the marriage, and the earning power it brings, are treated as assets to be divided.

While Ms. Tidwell seems resolute about cordoning off her debt and paying it off with money she alone earns, she and anyone like her probably ought to codify that intent in a legal agreement, even at the point they decide to move in with someone. And this only gets more complicated (and the agreements more crucial) in second marriages, where people may come to the relationship with assets, sole responsibility for a mortgage and a couple of college tuitions. Better to write it all down, no matter how clear the laws may be in your state.

In some ways, Mr. Kogler has it easy. There aren't a lot of unemployed doctors. So he and Ms. Tidwell should be able to pay back her loans (albeit over 20 or 30 years) as long as they live relatively modestly. He might feel differently if he were dating a lawyer with similar debt but less certain prospects, or an X-ray technician who would really like to be a photographer.

Still, all of this raises the question: At what point do you have a moral obligation to disclose your indebtedness during courtship? On the eighth date? When you get to third base? In your eHarmony online dating profile?

"It's a sliding scale," said Ms. Riesel, the Manhattan lawyer. "It depends on the person and the nature of the relationship." Ms. Winters, the Short Hills divorce lawyer, said it might depend on your definition of a serious relationship. "But I wouldn't wait until you were signing leases for apartments or picking out engagement rings."

Ms. Eastman in San Francisco says she knows that now. "What would I have done differently, besides bringing a copy of my credit report on the first date?" she said, with a rueful chuckle. "I would have been more responsible."

And while she hasn't dated anyone seriously enough in recent months to get to the point of disclosure, she says it's probably necessary by the eighth or 10th date. "I know that now," she said. "But it had never occurred to me that this is something that might end up being a deal-breaker."

Reading #3: When Sallie Met Barack

R. Jaafar | College Algebra and Trigonometry – Business and Finance (MAT115)

Source: Collins, G. (2009, May 27). When Sallie Met Barack. Retrieved February 14, 2011 from http://www.nytimes.com/2009/05/28/opinion/28collins.html

There are so many things I don't understand in this world. Why can't we do something about North Korea? Why are all the bees dying? How did I miss knowing about "Jon & Kate Plus Eight" until last week?

None of these things, however, are nearly as confusing as student loans.

There was a time when kids whose parents couldn't afford to pay for college just worked their way through. But the price has gone up so fast — more than twice as fast as inflation over the last two decades — that it's not an option any more, unless the student in question is planning to be a sophomore through 2020, or is exploring the possibility of part-time employment in armed robbery.

Students borrowed $19 billion in private loans last year, from a bewildering array of options. (Does anybody find it strange that Congress is patting itself on the back for passing a law that protects college students from being offered credit cards, while they're encouraged to commit themselves to tens of thousands of dollars in education debt?)

Some of the regular private lenders charge as much as 15 percent, although thanks to their dedication to the cause of learning, they are still protected from having their claims wiped away by a bankruptcy court.

Others sound as if they're nearly free, except when they aren't. This week, Jonathan Glater of The Times reported the story of Travis and Stephanie Gay, a couple in Kentucky who had borrowed about $100,000 to become special education teachers, under the impression that they could pay their loans off in five years via a special state forgiveness program for people who worked in low-salary service professions. Right after they got married last summer, the Gays got a letter from the state agency that ran the program saying that due to tough economic times, it was canceling most of their assistance and good luck with that debt.

And then, there's the epicenter of the college loan strangeness, the federally guaranteed loans. This is a system that goes something like this:

We the taxpayers pay the banks to make loans to students.

We the taxpayers then guarantee the loans so the banks won't lose money if the students don't pay.

We the taxpayers then buy back the loans from the banks so they can make more loans to students, for which we will then pay them more rewards.

Are you with me so far? Wait, I see a hand waving back there. What's that, sir? You want to know why the government doesn't just lend the money out itself? Excellent question!

The White House estimates that it could save about $94 billion over 10 years if it cut out all the middlemen. And it has the basis of a system in place, since the Department of Education already makes a lot of direct loans to students.

How many people out there think that there's going to be some reason that this turns out to be extremely controversial? Can I see a show of hands?

"Senator Nelson is for the system as it is now," said a spokesman for Ben Nelson, Democrat of Nebraska. If you are a big fan of Senate stalemates, you will remember Nelson, the star of such past triumphs as The Stimulus Is Too Big.

A great part of Nelson's resistance has to do with the fact that Nelnet, a big student loan provider, has its headquarters in his state. Last year, after an investigation by the New York attorney general, Andrew Cuomo, Nelnet was one of several student lenders that agreed to a settlement in which it paid a fine and promised to abandon alleged deceptive marketing practices and inducements such as offering free iPods to students who signed on the dotted line.

President Obama's proposal would allow the private companies to continue servicing the loans, protecting thousands of office jobs. However, they would no longer get the loan origination tasks, which involve the world of high finance and high pay. Stunningly, this turns out to be the part of the business that is most popular. (The chief executive of Sallie Mae, the giant in this line of work, made $4.6 million last year. The vice chairman made more than $13.2 million plus the use of a private jet.)

State agencies like the Kentucky Higher Education Student Loan Corporation, star of the Gay family debacle, also make federally guaranteed loans and they don't want to get out of the business. They like giving state residents money. They also enjoy using their profits to finance worthy enterprises — like loan forgiveness programs that run out of cash. Or, in the case of the Pennsylvania Higher Education Assistance Education Agency, spending $185,000 to send the board and staff to the Greenbrier resort in West Virginia for golf and spa treatments.

It's time for reform. The system is a mess. Possibly not as much of a mess as North Korea, but right up there with the dead bees and Jon and Kate.

4

ELEMENTARY STATISTICS

Energy and the Environment: Global Challenge (MAT120)

Project Quantum Leap

This course serves as a study of fundamental concepts and computational techniques of elementary statistics. Among the topics studied are: measures of central tendency, standard deviation, percentiles, statistical graphs, binomial and normal distributions, probability, confidence intervals, hypothesis testing, regression, and correlation. A statistical software package will be used by students to obtain basic sample statistics, to simulate fundamental theorems, and to assist with hypothesis testing. A graphing calculator will be used by students to assist with computations, as well as with tabular and graphical displays of data.

Aircraft Emissions

George McCormack
Department of Mathematics, Engineering, and Computer Science

Project Quantum Leap

Objectives

In this activity students will examine data from the airline industry about pounds of emissions of particulate matter from jets at low power levels. The mathematical objectives for this activity are: (1) calculate the mean, (2) calculate the standard deviation, (3) perform a hypothesis test about the difference of two means, and (4) perform a hypothesis test about a single mean.

Math Topics
Measures of dispersion and central tendency, hypothesis testing about single and paired means

Purpose
Synthesis

Comments
Data based on EPA report: *Procedures for Emission Inventory Preparation* (Volume IV: Mobile Sources)

When to Introduce
Week 8

Activity Time Frame
One week

Reflection

One of the main ideas of climate change is that entire characteristics of the environment are changing over an extended period for time. Climate change is not necessarily detectable over short periods of time, but a hypothesis test can indicate broad changes over long periods of time. When a hypothesis test is significant, it indicates that whole parameters of a population have changed, and that these may not be due to chance factors alone. This exercise gives students experience with numerical results that indicate systemic changes in the population under study, and, like the problem of climate change itself, these changes cannot be attributed to chance factors, but rather to the long term effects of man-made pollutants.

One source of global warming is the emissions generated by the airline industry. Jet travel has a significant impact on global warming, but not for the reasons most people would think. Unlike the automobile engine, the turbofan engine is extremely efficient at high altitudes and at cruising speeds. Therefore, the jet engines burn fuel completely with very low particle emissions. The problem comes from the particulate matter that is put into the atmosphere during the lift-off and take-off cycle (LTO). At these lower power levels, jets put large amounts of particulate matter into the atmosphere.

The particle output of ten planes was examined to develop the data for this exercise. The CO particles for each plane were calculated based on power levels, fuel flow rates, engine type, and number of engines per aircraft. It was estimated that a particular aircraft would taxi or idle for approximately 20 minutes during a low airport traffic LTO cycle, and would taxi or idle for 60 minutes if airport traffic conditions were heavy.

In this activity, students do a hypothesis test about the difference between two means and a hypothesis test about one mean. The two tests will yield similar information, but they will also give students the experience to think about data under investigation. In this exercise, students will learn to investigate data over a short period of time and over a longer period of time. Students are asked to imagine that they are investigating at an airport for CO emissions and congestion, and they have been asked to report about what they find to the FAA for recommendations for environmental protection.

Part of this exercise is intended to show students that there is something that can be done about particle emissions that result from congestion at airports. Cutting down the idle/taxi times at large airports can help to alleviate global warming.

Activity Overview

Reading: ***Aircraft Emissions*** reading needs to precede inquiry activity handout.

1. This activity is recommended after hypothesis testing has been introduced.
2. Introduce the lesson by allowing students to read a portion of the EPA report on particulate matter emissions in the airline industry (15 minutes).
3. Students should begin the problem in class by calculating the mean and standard deviation for the emissions data (30 minutes).
4. Students review an example of a hypothesis test on the difference of two means (15 minutes).

Materials and Resources

- Handout
- Reading: United States Environmental Protection Agency Air and Radiation. (1992, December). *Procedures for emission inventory preparation volume IV mobile sources* (EPA-R-92_009. Retrieved January 30, 2009, from http://www.epa.gov/OTAQ/invntory/r92009.pdf

Reading: Aircraft Emissions

McCormack | Elementary Statistics 1 Energy and the Environment: Global Challenge (MAT120)

Source: United States Environmental Protection Agency Air and Radiation. (1992, December). *Procedures for emission inventory preparation volume IV mobile sources* (EPA-R-92_009). Retrieved January 30, 2009, from http://www.epa.gov/OTAQ/invntory/r92009.pdf

5.1.1.2 Pollutant Emissions

Aircraft pollutants of significance are hydrocarbon (HC), carbon monoxide (CO), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), and particulates (PM10). The factors that determine the quantity of pollutant emitted are the emission index for each operating mode (pounds of pollutant per 1000 pounds of fuel consumed), the fuel consumption rate, and the duration of each operating mode. HC and CO emission indexes are very high during the taxi/idle phases when aircraft engines are at low power and operate at less than optimum efficiency. The emission indexes fall as the aircraft moves into the higher power operating modes of the LTO cycle. Thus, operation in the taxi/idle mode, when aircraft are on the ground at low power, is a significant factor in calculating total HC and CO emissions. For areas which are most concerned about the contribution of aircraft to the inventory of HC and CO, special attention should be paid to the time the aircraft operate in the taxi/idle modes.

NOx emissions, on the other hand, are low when engine power and combustion temperature are low but increase as the power level is increased and combustion temperature rises. Therefore the takeoff and climbout modes have the highest NOx emission rates. If NOx is a primary concern for the inventory area, special effort should focus on determining an accurate height of the mixing layer, which affects the operating duration of climbout.

Sulfur emissions typically are not measured when aircraft engines are tested. In evaluating sulfur emissions, it is assumed that all sulfur in the fuel combines with oxygen during combustion to form sulfur dioxide. Thus, sulfur dioxide emission rates are highest during takeoff and climbout when fuel consumption rates are high. Nationally the sulfur content of fuel remains fairly constant from year to year at about 0.05% wt. for commercial jet fuel, 0.025% wt. for military fuel, and 0.006% wt for aviation gasoline. This is the basis for the sulfur dioxide emission indexes in the tables included in this methodology. If the sulfur content of fuel varies significantly on a local basis, the emission index can be adjusted according to a ratio of the local value to the national value.

Particulates form as a result of incomplete combustion. Particulate emission rates are somewhat higher at low power rates than at high power rates since combustion efficiency improves at higher engine power. However, particulate emissions are highest during takeoff and climbout because the fuel flow rate also is high. It is particularly difficult to estimate the emissions of this pollutant. Direct measurement of particulate emissions from aircraft engines typically are not available, although emission of visible smoke is reported as part of the engine certification procedure. Particulate emission factors for only a few aircraft engines are included in this chapter.

Handout: Aircraft Emissions

McCormack | Elementary Statistics 1 Energy and the Environment: Global Challenge (MAT120)

Introduction

From the EPA report you have just read you learned that emissions from jet engines are at their highest during low power levels of the lift-off and take-off cycle (LTO), or when fuel consumption levels are the highest, such as during take-off. Typically, low power levels occur when a jet is preparing to take off, such as when it is taxiing to the runway or idling while waiting to take off. Therefore, the key to limiting emissions from aircraft is to limit the time spent at lower power levels. Eliminating airport congestion can go a long way toward controlling the harmful emissions that occur during taxi/idle times of aircraft on their approach to the runway.

Round trip taxi/idle times, from the gate to the runway and back, should not take more than an average of 20 minutes in an airport with light traffic. Airports that have enough runways and gates for the aircraft they service have low taxi/idle times because they are less congested. Airports that service more aircraft than there are facilities for exhibit higher taxi/idle times.

The table below shows pounds of CO emitted during heavy traffic and hence high taxi/idle times.

Problem A

Aircraft	Heavy Traffic lbs CO/High Taxi/ Idle times
Boeing 727	106.60
DC-10	211.86
Boeing 737	68.67
Boeing 747	356.67
DC-9	25.38
L-1011	478.44
DC-8	109.44
B 737-300	29.85
B747 F	356.91
A-310	30.96

1. Calculate the mean and standard deviation for both heavy and light traffic pounds of CO particulate matter.

2. Imagine you are conducting an investigation of an airport for CO particulate matter based on taxi/idle times. The airport you are investigating reports a mean pound particulate idle/taxi time of CO to be 59.16 lbs, but the mean pounds of CO that you, the investigator, calculate is: ______________ (*calculated mean for the above ten aircraft in heavy traffic/high taxi/idle times*). The standard deviation you record is: _____________ (*calculated standard deviation for the above ten aircraft in heavy traffic/high taxi/idle times*). Using the 5% significance level can you conclude the mean number of pounds of CO particles for this airport is still 59.16 lbs?

3. Long taxi/idle times in heavy traffic pollute the first 3000 feet of the atmosphere. From your

calculation what can you conclude is happening to the atmosphere closest to the ground?

4. What are some of the reasons that an airport might have heavy traffic?
5. What are some of the ways an airport might be able to reduce traffic?
6. Can you think of some economic reasons why an airport might not want to reduce congestion?

Problem B

As an FAA airport congestion investigator you want to know if CO particulate emissions have increased from 1998 to 2005 based on idle/taxi times. The following table gives the CO particulate emissions in pounds for 1998 and 2005. These data are calculated for the years 1998 and 2005 on the same aircraft.

In your textbook look up *inferences between two population means for paired samples*. Using 5% significance level, can you conclude that the number of pounds of CO particulate emission has increased between 1998 and 2005? Assume that the population of paired differences has a normal distribution. Based on this test what would you recommend to the FAA about congestion at this airport

1998	35.53	70.62	22.89	118.89	8.46	159.48	36.48	9.95	118.97	10.32
2005	106.60	211.86	68.67	356.67	25.38	478.44	109.44	29.85	356.91	30.96

1. Does this test indicate that there are fundamental changes in CO_2 emissions at this airport over the period in question?
2. Could the time of year these samples were taken affect the results of the test?

Reference for all data:

United States Environmental Protection Agency Air and Radiation. (1992, December). *Procedures for emission inventory preparation volume IV mobile sources* (EPA-R-92_009). Retrieved January 30, 2009, from http://www.epa.gov/OTAQ/invntory/r92009.pdf (p. 171)

Introduction to Algebra (MAT095)

This course has a problem-solving approach that emphasizes the importance of mathematical reasoning in addressing real-world problems drawn from diverse disciplines. Topics include arithmetic (signed numbers, fractions, decimals and percentages), elementary algebra (solving first-degree equations and inequalities, rules of exponents, equations of lines) and basics of geometry (area and perimeter) as well as numeracy (estimation, unit analysis). The course is intended for students with little or no algebra background.

Elementary Algebra (MAT096)

This course provides a careful treatment of elementary algebra, beginning with the line/linear equation, ending with the parabola /quadratic equation, and emphasizing the interplay between geometric and algebraic representation. Topics include graphing, systems of linear equations, functional concepts, rules of exponents, polynomial algebra, factoring, rational expressions, complex fractions, radical expressions, and the quadratic formula. Applications to linear and quadratic modeling are featured.

College Algebra – Trigonometry (MAT115)

This course will start with a review of basic algebra (factoring, solving linear equations, and equalities, etc.) and proceed to a study of polynomial, exponential, logarithmic, and trigonometric functions. These functions will be used in applications involving simple mathematical modeling where students will engage in inquiry activities aimed at improving critical thinking skills.

Elementary Statistics I (MAT120)

This course serves as a study of fundamental concepts and computational techniques of elementary statistics. Among the topics studied are: measures of central tendency, standard deviation, percentiles, statistical graphs, binomial and normal distributions, probability, confidence intervals, hypothesis testing, regression, and correlation. A statistical software package will be used by students to obtain basic sample statistics, to simulate fundamental theorems, and to assist with hypothesis testing. A graphing calculator will be used by students to assist with computations, as well as with tabular and graphical displays of data.

Critical Thinking (HUP102)

This course explores the process of thinking critically, and guides students in thinking more clearly, insightfully and effectively. Concrete examples from students' experience and contemporary issues help students develop the abilities to solve problems, analyze issues, and make informed decisions in their academic, career and personal lives. Substantive readings, structured writing assignments, and ongoing discussions help students develop language skills while fostering sophisticated thinking abilities.

General

Science Education for New Civic Engagements and Responsibilities (SENCER): SENCER robustly connects science and civic engagement by teaching "through" complex, contested, capacious, current, and unresolved public issues "to" basic science. http://www.sencer.net/

SENCER Backgrounder "Mathematical and Statistical Reasoning in Compelling Contexts" by Professor David L. Ferguson: This paper calls for increased emphasis on a vision of mathematical and statistical reasoning that situates these subjects in compelling contexts and thereby allows for the development of core mathematical concepts that can be interconnected to a variety of interests and purposes.
http://serc.carleton.edu/sencer/backgrounders/mathematical_reasoning.html

SENCER Model Courses: The SENCER models are curricular approaches to improving science learning and supporting engagement with complex issues.
http://www.sencer.net/Resources/models.cfm

Professor Michael Burke's Final Project Snapshot: A Carnegie-sponsored project on integrative learning in the math classroom, containing assignments from global warming, population of Ireland, to nuclear waste. http://www.cfkeep.org/html/snapshot.php?id=61548260563564

Mathematics Across the Community College Curriculum (MAC3): The goal of this project is to create a mathematically literate society that ensures a workforce equipped to compete in a technologically advanced global economy. http://www.mac3.amatyc.org/

The Center for Mathematics and Quantitative Education at Dartmouth: This Center's mission is to establish a collection of materials suitable for teaching quantitative literacy across all disciplines and levels. http://math.dartmouth.edu/~mqed/

Washington Center for Improving the Quality of Undergraduate Education: Learning Communities National Resource Center.
http://www.evergreen.edu/washcenter/pResources.asp?pid=73

American Museum of Natural History Center for Biodiversity and Conservation: The mission of this Center is to mitigate critical threats to global biological and cultural diversity by advancing scientific research and heightening public understanding of biodiversity. http://cbc.amnh.org/

Network of Conservation Educators and Practitioners Modules: Each module includes a synthesis document that brings together key background information and references for a topic, visual presentation with notes and discussion questions, and a practical exercise for laboratory or field use, with accompanying solutions.
http://ncep.amnh.org/index.php?globalnav=modules&sectionnav=about

Environment

Take Part: An Inconvenient Truth Study Guide http://www.takepart.com/ait/studyguides.html

Energy Information Administration: Official energy statistics from the U.S. Government. http://www.eia.doe.gov/

Energy Information Administration Brochure: Basic Information about Greenhouse Gases, Climate Change, and Energy http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html

America's Climate Choices: This booklet presents recommendations from the National Academies' many expert reports on climate change in an easy-to-read format. http://dels.nas.edu/basc/climate-change/

Woods Hole Research Center: Contains information on the global environment. The research center conducts various research and education programs related to the environment. http://www.whrc.org/resources/online_publications/warming_earth/the_greenhouse_effect.htm

The Encyclopedia of Earth: This is a new electronic reference about the Earth, its natural environments, and their interaction with society. It contains collection of articles written by scholars, professionals, educators, and experts who collaborate and review each other's work. The articles are written in non-technical language and will be useful to students, educators, scholars, professionals, as well as to the general public. http://www.eoearth.org/article/Atmospheric_composition_and_structure

Redefining Progress: This website contains an online quiz to calculate an individual's ecological footprint. It also contains information about sustainable economics and sustainability indicators. http://www.myfootprint.org

National Oceanic and Atmospheric Administration (NOAA): Part of the United States Department of Commerce, this agency conducts research to provide information about daily weather forecasts, severe storm warnings and climate monitoring, and supports fisheries management, coastal restoration and supporting marine commerce. http://www.noaa.gov/about-noaa.html

Personal and Public Health

Medline Plus: A service of the U.S. National Library of Medicine and the National Institutes of Health. http://medlineplus.gov/

Health Finder: An encyclopedia of over 1,600 health topics from the U.S. Department of Health and Human Services. http://www.healthfinder.gov/

Healthy People: This project challenges individuals, communities, and professionals to take specific steps to ensure that good health, as well as long life, are enjoyed by all. http://www.healthypeople.gov/

Physical Activity Guidelines: The U.S. Federal Government has issued Physical Activity Guidelines for Americans, which describe the types and amounts of physical activity that offer substantial health benefits to Americans. http://www.health.gov/paguidelines/

Healthier US Initiative: This initiative is a national effort to improve people's lives, prevent and reduce the costs of disease, and promote community health and wellness.
http://www.healthierus.gov/

Center for Disease Control and Prevention: Data and Statistics
http://www.cdc.gov/DataStatistics/

World Health Organization: World Health Report http://www.who.int/en/

New York City Department of Health and Mental Hygiene:
http://www.nyc.gov/html/doh/html/home/home.shtml

Finance and Business

Federal Reserve: The central bank of the United States, which provides the nation with a safe, flexible, and stable monetary and financial system. http://www.federalreserve.gov/

Federal Reserve Education: Links to instructional materials and tools that can increase students' understanding of the Federal Reserve, economics, and financial education.
http://www.federalreserveeducation.org/FRED/?CFID=2140616&CFTOKEN=73647566

Market Watch: This financial information website provides business news, analysis, and stock market data, as well as personal finance news and advice, and tools for investors.
http://www.marketwatch.com/

Dismal Scientist: Economic indicators and analysis.
http://www.economy.com/dismal/

Investopedia: Online stock and financial dictionary with investing links.
http://investopedia.com/

Yahoo Finance: A service from Yahoo that provides financial information.
http://finance.yahoo.com/