Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2008 Volume VI: Depicting and Analyzing Data: Enriching Science and Math Curricula through Graphical Displays and Mapping

Displaying Populations: Jellybeans, Paper and People

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Introduction

> "We did not weave the web of life.
> We are merely a strand in it.
> Whatever we do to the web, we do to ourselves" (Valentine, 2007)

Perched on top of a multitude of diverse flavors is a yellow-speckled cream-colored favorite. In the populous of diversely tantilizing flavors, only this one has the ability to satisfy. How many popcorn-flavored gourmet jelly beans are there in a bag I wonder? A count of each flavor would take some time. However, I could sort a percentage of jellybeans into rows to make a picture that will quickly assess how many of my favorite are likely to be in a bag. In the same way, the diverstiy of species within an area at a specied time can be accounted for. It is not so easy to line up organisms or plants as jellybeans, but an estimate of each type placed in a graph would give a fitting picture of the life within the space. Three criteria must be defined -- first, what is the population(s) secondly, what is the time frame, and third the area to be measured. Therefore population is defined by the number of entities with a given area, in a specified time.

For example, if we confine our research to humans on the earth, in the last fifty years, we will find this population has grown quickly and considerably. The human population has mutlipled expontentiallyAn estimate of humans on earth in1988 is 51.04 billion. The expodential growth rate since that time has been estimated at 1.5% per year, greatest at just over 2% in the early 1960's. At the turn of century, six billion humans hovering around a 1% increase per year since 1990, have graced the planet. The human population is expected to reach 9 billion by 2050. (TakingItGlobal, 2008). These figures are staggering to imagine, informative in a table and best represented pictorially in a graph. Students who are knowledgeable about their environment are more likely to make intelligent choices that contribute to world health (Guthrie, 2005). Graphs are effective visual tools to portray data and show trends because they present data quickly and informatively. Just like knowing how many popcorn-flavored jellybeans are in the bag for me to enjoy, students need to have a working knowledge of populations to make informed decisions in the future. This unit will take students through the steps of interpreting, creating, and analyzing population data displays.

New Haven Biology curriculum-embedded tasks are formative assessments designed to determine if students have grasped and can apply curricular materials. The focus of this unit is to provide teachers with methods and activity that will help the student establish connections to the curriculum and enhance both learning and application of the state mandated embedded task on human population dynamics. This task follows the population's unit required yeast and molasses lab where students discover the conditions that affect population growth. The Human Population Dynamics embedded task calls for a student-made graphic presentation comparing developed and underdeveloped countries based on the U.S. Census Bureau's population pyramids.

In this unit, students will also learn that graphs often portray more than one kind of information. The student will discover how to tell a story in a picture, manipulate a graphic display to tell another story, and utilize his or her own design to deliver a message. The lessons lead the student up to a practiced understanding of what a graph can represent and how to decipher the designer's message. The activities, intended to develop the many ways that data can be displayed will emphasize the value of graphic displays with respect to population dynamics. The lessons will also help the student to understand how to read and interpret graphic displays while exploring the way that populations grow and change.

Rationale

Many studies document the need for education of children on how they contribute to the health of their environment (Rutherford, J.F., & Ahlgren, A.1991). Organizing data is one way to help students understand their environment and be more successful. By teaching students how information can be organized, we increase their understanding of the meaning the data. Schools are identified as key settings for children to learn about the world as it grows and changes around them (DiTrolio, R.2002). Understanding the statistics of world through graphic interpretation may be a way to help students relate to population information. The world of high-speed internet has increased the transfer of information. Students can find out about what is happening in any part of the world in a matter of seconds (Bajorek, K.2008). Worldwide information and events may affect how we think and act. Our first responsibility in educating young people about the populations of the world is in teaching them to understand population growth and the effects humans have on the earth. This unit attempts to lead students through organization of data to make the interpretation and understanding clear and to express a specific meaning in the presentation of data.

The state embedded task calls for students to read and interpret population's pyramids created by the US Census Bureau. The task calls for analysis of the size, shape and meaning of the population from a developed country in contrast to an undeveloped country. To complete this task, students should have a clear understanding of the conditions that influence populations and how this information is interpreted from a population pyramid. Further, students explore projected results for populations and determine the affects of technology on these populations. Lastly, students need to collate this information into a formal presentation.

Population dynamics are all the factors that affect the size, shape and growth of a population over time. Population change is due to several inherent factors; resource availability, technological change, climate change and genetic variability. The dynamics of populations are the ways in which the numbers of individuals in a population grow and shrink. Populations have two inputs and two outputs determining their dimension. Simply put, inputs are either births or immigration. The two outputs are the opposite; emigration, where organisms move out of the population for a variety of reasons, the second is death. When the inputs are equal to the outputs the population is in balance, this is when a population graph's line would have a slope of zero, and the number of organisms reaches the carrying capacity for the area the population inhabits.

Population is often described in terms of density, the number of organisms in a specified space. In terms of organisms, other than humans, a population's carrying capacity is largely due to the resources needed for survival in a habitat. Humans, however, have developed methods to ensure the carrying capacity of their locale continues to increase, as does their life expectancy. The human population is an exception, rather than the rule in nature. Humans have endeavored to control world population. Some authors have gone so far as to state that humans have endeavored to cleanse their population in favor of what a few deem as necessary population control (Connelly, M.2008). In any case, humans adapt their environment to suit their own needs in a way no other organism in the history of the earth.

In displaying population growth, graphs are easy to use because they are made of lines, dots and simple symbols that are uncomplicated and quick for students to draw. Graphs can show relationships between variables or show the rate of change of a given variable. If a point needs to be expresssed, a change over time depicted, or comparison shown, graphs are useful tools. Edward Tufte, a Yale University professor, suggests in his book on graphs and graphing that misleading or unclear graphics, charts, and tables can sometimes have disastrous effects (Tufte, E.2001). To help students understand change in populations of the great diversity on earth the relationship among changes as they occur, students must learn how graphing can enhance or alter the message. Through lecture, display and discussion in the seminar "Depicting and Analyzing Data; Enriching Science and Math Curricula through Graphical Displays and Mapping," Dr. William B. Stewart helped participants grasp a thorough understanding of the importance of each facet of graphical display. Every component of a graphic illustration may be analyzed to construct realistic population representation convey the desired message. Only people have the ability to set in place global change. By examining the relationships between organisms through data collection and graphic display, we can reach an understanding of the relationships between lifeforms, ecosystems and people for the harmony of all.

As the unit begins, the I Didn't Know That (*IDKT!)* sheets are distributed to students. This quick half-sheet paper is a strategy to monitor student understanding, and will serve three purposes. In the five minutes before each lecture or activity and the five minutes at the end, student will have the opportunity to focus their attention to making connections with the subject at hand. *IDKT!* is based on the K-W-L teaching strategy. In K-W-L; K equals what the student knows, W equals what the students want to know, and L equals what the students learns. Using *IDKT!* the teacher can quickly assess what the students know early in a lesson and address any misconceptions as the activity begins. At the end of the lesson students write what they learned and ask questions. Teachers can review the answers and plan for the next lesson based on student input. The *IDKT!* sheets can also be used as a type of data collection throughout the unit. Teachers should set up specific objectives for student learning to collect good data. The quality of an answer should be discussed with students to obtain good data for a final assessment for the unit. *IDKT!* worksheets show student progress as they learn the vocabulary necessary to understand populations. The important vocabulary for this unit is demography, density, dispersion, immigration, emigration, growth rate, growth curve, simulation, and estimation.

The study of demography is important to this unit. Demography is the statistical study of populations to examine how a population may change. There are three key characteristics of a population's demography -- size, density and dispersion. The size of a population is simply the number of organisms, counted or estimated. Density is the number of organisms in a specified area and dispersion is how the organisms are grouped with in the habitat. Sometimes organisms are concentrated in a specific space, other times they are evenly distributed throughout the area. A species can also be randomly dispersed throughout a habitat. Immigration refers to organisms moving into an area and emigration refers to organisms leaving an area.

Students can determine the growth rate of the population to understand how populations change. The growth rate is the death rate (number of people who expired) subtracted from the birth rate (number of new births) and helps demographers predict population growth. Death rates are affected by nutrition, infant mortality, public health care and environmental quality. Birth rates are affected by the fertility rate (number of children per woman), which is determined by economic, social and biological factors. Economic factors affecting the fertility rate are child labor, cost of rearing children and pension plans. Social factors include migration, economic development of a region, and education for women, employment for women, marriage age, religious beliefs and urbanization. Biological factors included infant mortality rates, birth control methods and family planning. The growth rate (r) is considered a major factor in predicting population growth.

Growth curves whether J-shaped (showing exponential growth) or S-shaped (showing logistic growth) help students see how populations change. Population growth is estimated in terms of a logistic growth or exponential growth. A typical equation for determining the logistic growth of a population may look like:

$dN/dt = r_{max} N ((K - N)/ (K))$ or $dN/dt = r_{max} N (1 - (N/K))$.

Where dN/dt is the growth rate of the population, r_{max} is the maximum growth rate for a specific species in a certain environment, K is the carrying capacity, and N is the total population. In a logistic growth model, the growth rate decreases as the population increases, an inversely proportional relationship. Mathematical equations for predicting population size are usually based on book published in 1798 by Thomas Malthus utilizing the equation $pt_{+1} = r X p_t$. In this equation p_{t+1} (population size at the next time-period) equals a Malthusian factor that determines growth rate (r) multiplied by p_t (population at the time ($_t$)). This equation, known as the difference equation of exponential growth, allows you to find the population size at separate time intervals. (Bulaevsky, J.1997). In exponential growth, the larger the quantity, the faster the population grows in absolute terms. Exponential growth demonstrates a directly proportional relationship. In exponential growth, although the increase in the population size is seems slow over a short period, the growth becomes impressibly larger over a longer period as the initial quantity continues to double.

Students investigate in the last part of this lesson: how the density and dispersion of a species can limit the carrying capacity of a habitat by examining influencing factors and habits of populations. Demographers have defined two types of growth strategies in population density. Growth rate or r-strategists are organisms that have relatively short life spans, reproduce quickly producing many young and provide little parental care. Derived from the equation where growth rate equals $r_{max} N (1 - (N/K))$, r-strategists, are often opportunistic species. Most weeds are examples of r-strategists. K- (or carrying capacity) strategists are organisms with long life spans, they tend to reproduce slowly, have few young and strong parental care are considered the stable species. Large mammals are good examples of K-strategists. r- and K-strategists play distinct roles in ecological succession of an ecosystem. Most organisms display both r- and K- strategy characteristics. For example, trees disperse many un-nurtured seeds of the r-strategist; however, they also display longevity and stability of K-strategist.

Computer simulations attempt to model possible scenarios based on mathematical computations. Simulations provide mathematical models for observing predicted results. Simulations also help provide estimations, calculated approximate values for statistical models also based on mathematical equations. In the next lesson, students watch how a population changes and grows using a computer simulation at Shodor.org. As the size of the populations of rabbits and wolves changes students learn about probability, randomness and chaos in a simple ecosystem. Graphic displays show students how the data can be represented, and a series of exploration questions guide students to conclusions. Students work in pairs for about thirty minutes to determine why the rabbit population grows so fast and can predict probabilities for the future. Afterwards, students look at a population in a fixed habitat that explores factors that influence populations and then practice two ways that demographers use to estimate populations. After looking at the diverse world of organisms, student will then begin to investigate their own population and the influences on human population that exist today that will determine the statistics of the future.

Human Populations

Since World War II, the global population has nearly quadrupled and it is estimated that the earth is now home to 6 billion people. This increase is attributed to many factors. The agricultural revolution that taught people how to produce more food contributed to sustainable societies. The discoveries of germ basis of disease and subsequent development of vaccines, antibiotics and sterilization techniques have contributed to increased life expectancy. Individuals, who had little or no chance of survival fifty years ago, live productive life’s today thanks to technology (Environmental Literacy Council, 2008). To examine human population growth and the factors that determine it, students will first examine population pyramids using gourmet jellybeans. This activity helps students in grouping and estimating populations, displaying data in a physical graph, and interpreting change in a population pyramid.

The next lesson focuses on human populations and how to represent real world data from tables and charts. Students learn the details of a population pyramid, what each axis represents and how to interpret a human population pyramid. Some factors affecting human populations are health, labor force, education, government, religion, housing, transportation, space, and climate of a particular area. Influences on populations are availability of resources such as food and water, space to live and grow and movement in and out of the population. Humans may have influences that are more specific and complex, such as a where to reside, buy groceries, and obtain an education or medical care, employment, and access to transportation and leisure activities. Outside factors such as immigration, emigration, government policies, new ideas, technology or negative influences such as war, plagues, and natural disasters shape the ways in which a society can evolve. The many internal aspects of culture can influence developed countries: religious conviction, politics, historical past and finances. The size and type of subcultures also influence a population. The more diverse the types of subcultures in a population, the more varied the accommodations that have to be made for them.

As human populations grow, they have a profound affect on the environment. Most organisms adapt to the habitat in which they live and over time have evolved into unique organisms. Humans have made more of an impact on the ecosystems of the earth because they are continually changing the world to suit themselves.

The advent of agriculture completely changed how human beings have thrived. In addition, the rudiments of technology were the beginning of the enormous changes that would affect the life of countless other organisms in diverse ecosystems throughout the world. No longer nomads, human beings build homes, roads and sidewalks, fenced the lands and herded domesticated animals to slaughter for food. What is certain is that we must continue to ask questions about the source of the goods we use and consume. Children must love the earth in order to save it. An important goal of any education is teaching environmental stewardship of the earth.

The extraordinary decrease in mortality worldwide had much to do with the availability of antibiotics, vaccines, and pesticides but most notably to the agricultural revolution. Life expectancy more than doubled. The expectation is that the population will continue to grow over the next two decades, because a great percentage of the population in the most populated countries will reach childbearing age during this period. By contrast, in developed countries, the total fertility rate, an average number of children a woman has in her lifetime, is declining. People are having fewer children and are living longer. The average age of the population is increasing worldwide. It is not clear how nations will cope with a large elderly population. In developed countries, the needs of the elderly and the young will put considerable strain on the working middle age group. In undeveloped countries, lack of food and clean water has more acutely affected fertility rates. As teachers and students work through this unit, many questions will be asked that have no easy answers. Whether population control is reasonable and necessary is being tested in countries like China. Some people feel that population control is unnecessary, that in nature exists a means of controlling populations. Others feel that humans have the ability to manipulate their environment and therefore should control population growth so that a selection of humans will get the best use out of the resources that are available. There are valid arguments for both sides, too lengthy for this unit but resources are provided for further research. As students present their work, teachers may want to explore these issues.

The last lessons in Lesson Plan III helps students prepare a presentation that fulfills the stated embedded task, Human Population Dynamics. Students will examine US Census Bureau population pyramids, chose two countries that have very different pyramids and compare them in their presentation. Through the lessons in this unit, students should now be prepared to interpret the population pyramids and make informed interpretations and predictions. Students are given a rubric that they can use to organize their presentations. The rubric guides students through the format and encourages them to make presentations that show they have learned to compare graphic displays, interpret data and make valid predictions.

Lesson Plan IV is an optional plan to further student exploration of the use of data and graphing. Teachers could present data from various sources to students and stimulate conversation about why the author displayed the data as they did.

Teachers can also now use the data collected through use of the *IDKT!* sheets to make a table of real world data for students to analyze.

Students have learned about the use of graphs to display data and tell a story through the exercises in this unit. One promising way to help student retain the knowledge, practice and presentation of this information is to have them research a career of their choice and discover how data is used in that career. Students are sure to find multiple uses of data collection and graphing skills in most any career. A few examples are ; in medicine, when a patient needs a medication the doctor consults a chart showing the amount of medicine to prescribe in accordance with the patients body size. In architecture, an architect uses graphics to display the amount of stress they can expect a specific material to withstand. In statistics, graphs show trends or comparisons, city planners use this information to determine where to build roads or allow commercial buildings. Manufacturers use data to decide when or where to release a product and athletes use data and graphs to improve performance. The examples are countless. The final project could be a graphic display of data from a student's choice of career and an explanation of how the data is important.

This unit has not discussed the many ways data can be displayed or the ways in which data can be manipulated to tell different points of view. The resources provided will help teacher prepare further lessons on statistical, qualitative and quantitative analysis of graphic displays. The intent of the writer is to give teachers background for instruction of students to understand and complete the Connecticut state embedded task with clear interpretation of the population data from the US Census Bureau. The subject of data and graphic display is vast and the reader is encouraged to research further and enjoy the beauty of design, simplicity of method and wealth of information that is displayed in a single picture.

Unit Objectives

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1. To identify at least three trends in population growth
2. To evaluate role of changes in birth, death, immigration, and emigration rates on population size.
3. To develop a familiarity with mathematical basis of population dynamics
4. To recognize major trends and issues in global population dynamics;
5. To develop an understanding of the biological concepts of population dynamics
6. To construct realistic population models
7. To translate statistics on population growth to percentages
8. To gain a historical understanding of changes in a long life
9. To predict life expectancy in the future based on current life span data
10. To translate population information from graphs to maps and visa versa
11. To analyze population information and draw conclusions
12. To define the terms developed and underdeveloped countries
13. To locate and compare population pyramids
14. To interpret population pyramids to generalize about the growth of a population.
15. To identify reasons for changes in population growth, challenges, opportunities and resources.
16. To develop an understanding of how scientists estimate populations
17. 17. To practice population sampling techniques

Lesson plans

Lesson plans are geared to take approximately one week depending on the background and abilities of the students. (In Connecticut, the yeast populations lab embedded CAPT(Connecticut Academice Performance Test) lab should be completed or run concurrantly with LP1. Lessons are presented in an order the writer believes will be most beneficial to the student. Depending on your student population and available time, additional depth and research may be explored.

Lesson Plan1 -- Introduction & vocabulary, review skills

I. *IDKT!* I Didn't Know That!
II. The Hook --A Changing Population-Dubaithan presentation
III. Populations vocabulary worksheet- Definitions & Introduction
IV. Graph interpretation

Lesson Plan 2 -- A look at population change- factors than influencing population change

I. Rabbit & Wolf Population Simulation Webquest -- how populations change
II. Deer population worksheet -- factors influencing populations & vocabulary
III. Estimating Populations- Mark & recapture

Lesson Plan 3 -- Human Population Dynamics

I. Jellybean Country- hands-on graphing
II. Mapping it out -- paper strip population pyramids
III. How it is done- instructions for creating making a presentation
IV. State embedded task; Human Population Dynamics - student presentation

Lesson Plan 4 -- Data collection and display

I. Methods of data presentation- Graphs & Data Display
II. Using IDKT for final assessment for the unit -- students create their own chart and graph of the data graded heavily on creativity and representation of the data
III. Careers in Data Display- optional wrap up

Resources for Students

1. DiTrolio, R. (July 2002). *When am I ever going to use this?* Retrieved April 6, 2008, from R. Ditrolio Career Webquest Web site: http://www.dedham.k12.ma.us/webquest/summer2002/rd/R.%20DiTrolio%20Career%20WebQuest.htm

2. Holt, Rhinehart, Winston (2002). *Modern Biology* .Austin.A. Harcourt Classroom Education Company

3. Kimball, J (2007). Human Population Growth. *Kimball's Biology Pages* , Retrieved March 27, 2008, from http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/P/Populations.html

4. Tufte, E. (2001).The Visual Display of Quantitative Information. Second Edition. Graphics Press LLC

5. U.S. Census Bureau. (2006). International Data Base. Retrieved May 25, 2008, from U.S. Census Bureau, Methodology and Standards Council Web site: http://www.census.gov/ipc/www/idb/pyramids.html- database

6. U.S. Census Bureau. (2006). *POPClocks.* Retrieved April 4, 2008 from U.S. Census Bureau. U.S. and World Population Clocks Web site: http://www.census.gov/ - current statistics

Resources for Teachers

1. Bajorek, K. (March 31, 2008). *Population Studies* . Retrieved May 26, 2008, from Environmental Literacy Council Web site: http://www.enviroliteracy.org/subcategory.php/30.html

2. Bulaevsky, J. (Nov 1997). *Interesting Facts about Population Growth Mathematical Models* . Aryctech.org May 25, 2008 from http://www.arcytech.org/java/population/facts_math.html

3. Connelly, M. (2008). *Fatal Misconception* . Cambridge, MA: The Belknap Press. -- how world population policies have shaped populations

4. Diamond, Jared (2005). *Collapse* . New York, NY: Penguin Books. Societies choice- success or failure

5. Diamond, Jared (1999). *Guns, Germs, and Steel* . New York, NY: Penguin Books. -- history of why societies have diverse fates

6. Environmental Literacy Council. (2008). *Environment and Society* . Retrieved May 16, 2008 from http://www.enviroliteracy.org/category.php/5.html

7. McGinley, M. (2008). *Logistic growth* . The Encyclopedia of Earth. Retrieved May 16, 2008 from http://www.eoearth.org/article/Logistic_growth

8. Rutherford, F. James, & Ahlgren, A. (1991). *Human Society* . Science for All Americans Online. Retrieved March 25, 2008, from http://www.project2061.org/publications/sfaa/online/chap7.htm

9. TakingItGlobal (2008). *Best Practices in Global Education and Collaborative Technologies* . Retrieved April 6, 2008, from Taking It Global Web site: http://www.takingitglobal.org/tiged/bpcontents/index.html

10. Tufte, Edward Rolf (2001). *The Visual Display of Quantiative Information* . Cheshire, CT: Graphics Press.

11. UNESCO, (2006). UNESCO *Teaching and Learning for a Sustainable Future* . Global population patterns and trends. Retrieved April 4, 2008, from http://www.unesco.org/education/tlsf/TLSF/theme_c/mod13/uncom13t01.htm

12. United Nations Population Fund (1999). *The State of the World Population 1999* http://www.unfpa.org/swp/1999/index.htm - populations and peoples choice --

13. United Nations Population Fund (2007). *The State of the World Population 2007* , Retrieved April 1, 2008, from http://www.unfpa.org/swp/2007/presskit/pdf/sowp2007_eng.pdf - world population data

14. The Global Athletic Shoe (2007). Retrieved May 26, 2008, from University of Minnesota Human Right Resource Center Web site: http://www1.umn.edu/humanrts/edumat/sustecon/others/globalshoe.htm

15. Valentine.R. (2006) Translator. *Anishinaabemowin* . Retrieved Feb 14, 2007 from http://www.first-ojibwe.net/

16. World Fact book, The. (2008). *China* . Retrieved June 26, 2008 from https://www.cia.gov/library/publications/the-world-factbook/print/ch.html

Appendix A

NSE Standards Covered

LS 4c: Organisms both cooperate and compete in ecosystems.
LS 4d: Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite.
LS 4e: Human beings live within the world's ecosystems.
LS 5e: The distribution and abundance of organisms and populations in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials.
UCP 1: Systems, order, and organization
UCP 2: Evidence, models, and explanation
UCP 3: Change, constancy, and measurement
UCP 4: Evolution and equilibrium
UCP 5: Form and function
SAI 1: Abilities necessary to do scientific inquiry

SAI 2: Understandings about scientific inquiry
SPSP 2: Population growth
SPSP 3: Natural resources
SPSP 4: Environmental quality
ST 1: Abilities of technological design
ST 2: Understandings about science and technology
HNS 1: Science as a human endeavor
HNS 2: Nature of scientific knowledge
HNS 3: Historical perspective

Appendix B

Worksheets and links to information

Lesson Plan 1

I. Introduce *IDKT!* daily worksheet (copy two into word processors and have ½ sheets available to students for each day of the unit- Unit Objectives #1, 4,11,12,15.

IDKT! – I Didn't Know That! Name ____________________

What I thought before this lesson was… ____
____ more on the back->
What I learned from this lesson is… ____
____ more on the back->
What I want to know more about is… ____
____ more on the back->

II. *Dubai presentation* slide show-(please email beitlerbiologyyahoo.com for this presentation) or make your own from *http://adventure.howstuffworks.com/dubai-uae1.htm* or *http://www.tutztutz.com/2008/02/dubai-what-the-hell-is-going-on-over-there/* . This is the "hook" for the unit. Ask students what they know about United Arab Emirates in the Arabian Peninsula.The presentation shows the changes that have taken place in this area over a twenty year period. The city of Dubai changes from a dessert with a few high rises to a lush oasis with man-made islands and the tallest building in the world.

III. *Populations Vocabulary* (Teachers, please copy & format the worksheet below to include space for answers). Unit Objectives # 3,5,11, 14, 15.

Population Vocabulary

Name ______________

Population: all the individuals of a species that live together in an area

Demography : the statistical study of populations to make predictions about how a population will change

Three Key Features of Populations -- Size -- Density - Dispersion (clumped, even, random)

Growth Rate = Birth Rate - Death Rate

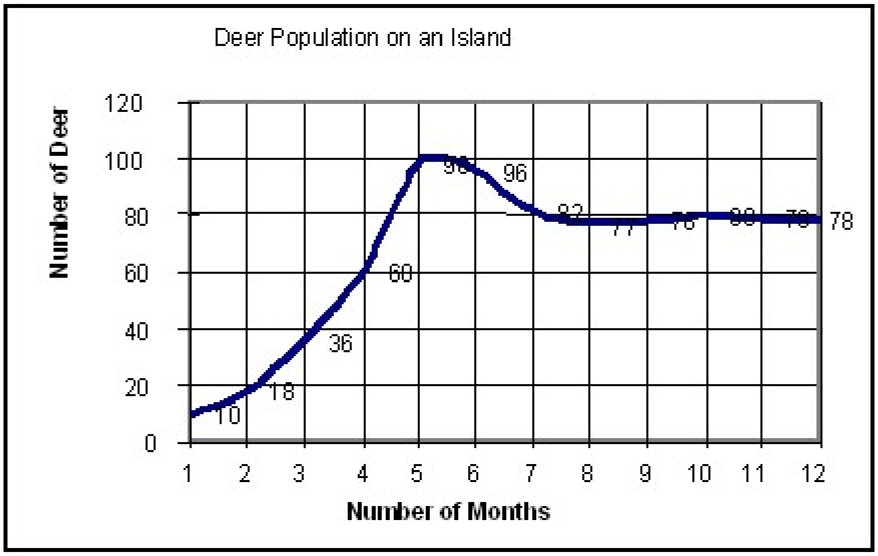
1. In Voorheesville, 15 babies were born in 2000, 4 residents died. What is the growth rate for Voorheesville? Population =15,243.
2. In Acheron, 70 babies were born in 2000, 80 residents died. What is the growth rate for Acheron? Population = 17,256.

Growth Curves

J - Shaped (exponential growth) S - Shaped (logistic model)

Populations are limited by space, food. That limit is called the carrying capacity.

3. At what level do the deer reach their carrying capacity?



What Limits Population Size?

Define Density:

Density-dependent factors: limited resources- space, food, water, air

Density-independent factors: random occurrences that can limit population - earthquake, bad weather

Natural Growth or Mortality Rate = Birth rate -- death rate

Choice factors: Emigration (population moves out) or Immigration (population in)

4. Is disease density dependent, or density independent?

Growth Strategies

R Strategists

· long life span
· reproduce slowly
· have few young
· parental care

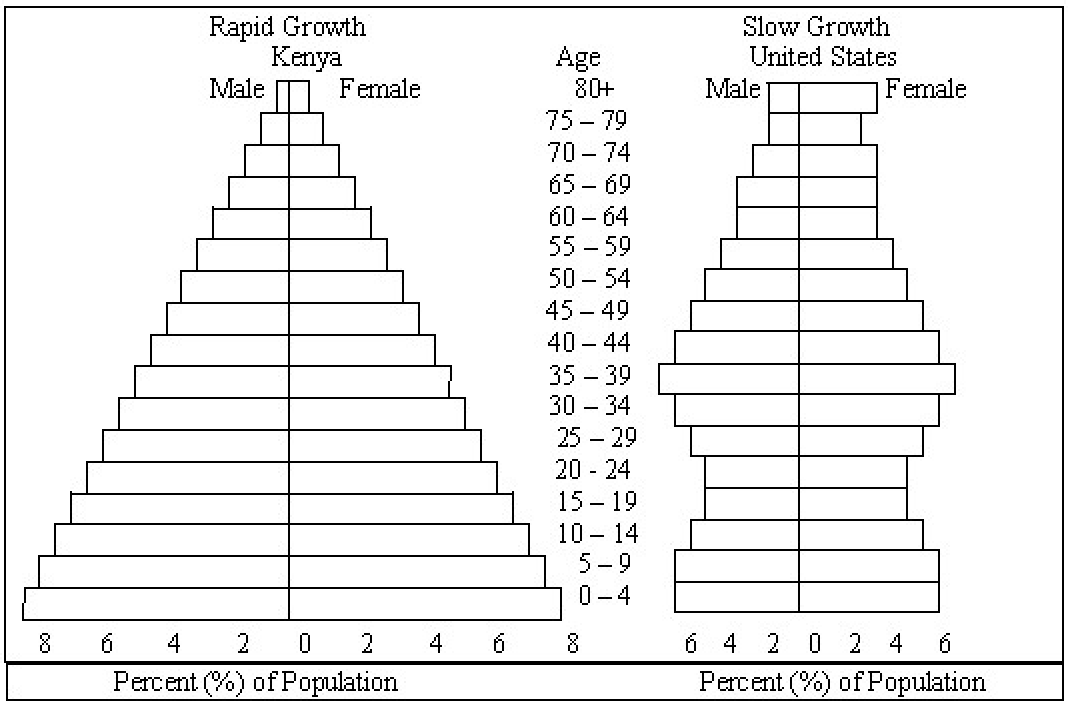
K Strategists

· short life span
· reproduce quickly

· have many young
· little parental care

5. Give two examples of an R strategist population and two of a K strategist population.

Population Pyramids



6. Which country would be considered an undeveloped country based on these population pyramids? Explain your answer and give reason why.

IV . *Graphing Interpretation* ; five exercises in Graph interpretation. Web-based lesson at http://fds.oup.com/www.oup.com/pdf/elt/catalogue/0-19-431517-7-b.pdf

Student complete 3-page exercise practicing graph interpretation and reviewing graphing vocabulary. The exercises expose students to standard vocabulary and ask students to interpret line graphs and pie charts. Students are asked to make comparisons and deduce the meaning of the diagrams.

Lesson Plan 2

I. Rabbit & Wolf Population Simulation Webquest -- This website examines the effect of changing a number parameters that determine the manner in which populations change in an artificial ecosytem, teacher should copy and paste the worksheet and reformat leaving space to answer questions in the activity. Give students graph paper and instruct them to follow the instructions exactly. Student first set up parameters for the simulation, then they take a short quiz on making a table. Returning to the simulator, instruct students to pause the simulation as the x-axis on the population graph gets close to 50, they can ‘step simulation’ and record data and then ‘resume simulation’ to continue. The first simulation is a closed area, an island, compared to a toriod or land without a border. In the island demonstration, rabbit populations exist past 200 generations, in the toroid simulation, both rabbit and wolf populations cease to exist after 200 generations; have the students discuss factors influencing populations. Copy and reformat the worksheet below for students.

Teachers can also make this a physical activity by cutting out small and large rabbit feet and wolf paws and assigning students to represent these animals. Students cross a set area hopping or walking depending on their assigned animal and are captured or reach their destination.. Rangers keep track of rabbits and wolves. New births are determined by the number of animals that reach safety each crossing. Natural selection is also extrapolated as student see large-footed rabbits outlive the smaller footed rabbits because they can move farther and escape the wolves.

Unit Objectives #2, 3, 5, 7, 8 ,9, 10, 11, 15

Rabbits & Wolf Simulation -- Population Graph Activity

This is a fun activity that will simulate population growth of a rabbit/wolf population in a forest. GO TO: ->http://www.shodor.org/interactivate/activities/RabbitsAndWolves//

FIRST: View/modify parameters --

VIEW/MODIFY RABBIT PARAMETERS

Maximum Rabbit Food Level - 45

Rabbit Metabolism Rate - 3

Rabbit Reproduction Age - 10

Rabbit Reproduction Probability - 50

Rabbit Reproduction Food Level - 40

Maximum Rabbit Age -- 25

Save changes

VIEW/MODIFY WOLF PARAMETERS

Maximum Wolf Food Level - 200

Wolf Metabolism Rate - 2

Wolf Reproduction Age - 10

Wolf Reproduction Probability - 50

Wolf Reproduction Food Level - 120

Maximum Wolf Age -- 25

Save changes

VIEW/MODIFY START UP PARAMETERS

Initial Number of Rabbits - 20

Initial Number of Wolves - 5

Initial Rabbit Food level - 10

Initial Wolf Food level - 150

Initial Grass level -- 20

Save changes

VIEW/MODIFY MISC. PARAMETERS

Rabbit Food Value (for Wolves) -- 10

Grass Growth Rate -1

Save changes

Be sure your parameter match those above for each category!

THEN: Return to Simulator **>>**

CHECK: Settings for the Simulator

SIMULATION 1: Forest size **Small** Speed: (**center**) Forest Border: **Island**

	Initial	50 generations	... 100	...150	...200
# of Rabbits living					
# of Rabbits died					
# of Rabbits born					
# of Wolves living					
# of Wolves died					
# of Wolves born					

CLICK:View Population Graph -> View Cumulative Stats -> record in your table

THEN: open a new window (File->New Window) and

>GO TO: http://www.mcwdn.org/Graphs/Tables.html - Take the Tables Quiz -- If you get 100% you do not need to return to the main page and read how to make a table!

Make a Table for Data -- Simulation 1 -- Island, on your graph paper

> GO BACK: To the Simulator and Start SIMULATION 1> Record in your Table e

Note: You will need to step the simulation when it gets close to the number of years you need to record so that you don't miss it! Watch the X-axis on the population graph, PAUSE BEFORE you get to desired year! View the Cumulative Statistics and record in your table for 50, 100, 150 and 200 years or as close as you can get! If you miss your generation year then you will need to reset the simulation and try again.

Make a second Table and change your parameters for the simulator to:

SIMULATION 2: Forest size **Small** Speed: (**center)** Forest Border: **Toriod**
-> Go to *Using Graphs* at http://www.statcan.ca/english/edu/power/ch9/using/using.htm

Read & *answer* the questions at the bottom on one side of your graph paper (use pencil!)

Use *Lab Write* at http://www.ncsu.edu/labwrite/res/res-homepage.htm to create a graph from your data.

Homework Questions:

1. What happened in *each* simulation to the total numbers of rabbits and wolves?
2. Suggest an explanation for the outcome of *each* simulation.
3. Explain the differences in the data you collect from an island simulation and a toriod forest simulation. What caused the difference in the simulations after 200 generations?
4. Do you think these two organisms live in balance in nature? Why or why not?
5. Explain who are the predators and prey in this simulation.

II . *Deer population* ;Teachers should email beitlerbiologyyahoo.com for this worksheet.

Unit Objectives #2,3,5,7,9,10,11.

This worksheet has students examine data from a fixed area, an island, when wolves are introduced to control the population of deer. Students will graph the data and answer a series of leading questions about the changes in the deer and wolf populations. The focus of this activity is the question of whether or not predators should be introduced to control population.

III. Estimating Population Size -- Unit Objectives: # 10,11,16,17

For this lab, you will need to make enough ‘populations’ for your class to have one per group/pair. For my class, I have 12 plastic bags (1 per pair of students) pre-counted and marked with a letter (A through L). I keep a list of the number of organisms per bag. Some items to use for your ‘populations’ are beans, macaroni, beads, plastic dinosaurs, or bugs even miniature cars. Students seem to enjoy the toys more and they may give a better mental representation of a population. In addition, a strip of masking tape is given to students to use to “mark” the individuals in the population. Instruct students to make a prediction before the activity of how they would determine the number of flounder in the harbor, encourage them to write down any ideas; there are no right or wrong answers. Copy & paste the worksheet below and reformat for your students, leaving ample space for predictions and answers. After the activity be sure students remove any marks so the next class starts fresh.

Estimating Population Size

Name_____________

Guess work: You are in charge of a team given the responsibility to determine the number of flounder in New Haven harbor, discuss with your partner how would you accomplish this task and describe in detail below.

Technique 1: Sampling

Sampling is used to estimate population size; in this procedure, the organisms in a few small measured areas are counted. Based on these numbers an estimate is made for the entire area . For instance, if a biologist counts 10 squirrels living in a 200 square foot area, she could predict that there are 100 squirrels living in a 2000 square foot area.

1. A biologist collected 1 gallon of pond water and counted 50 daphnia. Based on the sampling technique, how many daphnia could be found in the pond if the pond were 20,000 gallons.
2. What are some problems with this technique? What could affect its accuracy?

Technique 2: Mark and Recapture

In this procedure, biologists use traps to capture the animals alive and mark them in some way. The animals are returned unharmed to their environment. Over a long time period, the animals from the population are trapped at intervals and data is taken on how many are captured with tags. A mathematical formula is used to estimate population size.

Procedure:

1. You will receive a bag that represents your population. Make a data table like the one shown below.
2. Capture 10 “animals” by removing them randomly from the bag.
3. Place a mark on them using masking tape and return the all “animals” to the container

4. With your eyes closed, select 10 “animals” from the contain one at a time. This is the recapture step. Record the number of “animals” recaptured that have a mark on the data table. Mark any with tape that did not have tape on them.

5. Return the “animals” to the bag and repeat. Complete a total of five blind recaptures.

6. When the ten recaptures are completed, enter total the number captured on your data table and the total number of recaptured (that have a mark)

Trial Number	Number Captured	Number Recaptured (with mark)
1	10	0
2	10	
Total	50	

Data Table

Calculations

In order to estimate your population size, follow this formula

Estimate of Total Population= (total number captured) x (number marked)

(total number recaptured with mark)

7. What is the estimation of your population? (Show your calculations below)

EstimatedSize ________

8. Repeat the experiment, add 15 more data fields to the five trials you already have. Recalculate your estimate using the formula.

EstimatedSize ________

9. Use the code name on your bag to check with the teacher about how many “animals” are really in your population.

Name on Bag ___________________________

Actual Size _____

Analysis

10. Compare the actual size to the estimated size. Did you overestimate or underestimate?
11. What does this say about the number of trials that should be conducted in a real mark and recapture?
12. Given the following data, what would be the estimated size of a butterfly population in Edgewood Park? A biologist originally marked 50 butterflies in Edgewood Park.
Over a month long period, butterfly traps caught & released 600 butterflies. Of those 600, 150 were found to have tags.

13. In what situations would sampling work best for estimating population size, in what situations would mark & recapture work best. You will probably have to think about this one! Justify your answer.

*Remove all 'tags' before returning your population!

Lesson Plan 3 -- Human Population Dynamics

I. Jellybean Country- a hands-on graphing activity that allows students to build a human population pyramid out of gourment jellybeans. Materials: Plastic bag with 50 jellybeans (gourmet have more colors) for each student, do not choose them, the populations should make varied pyramids -- this sets the stage for comparison and discussion. Napkins or paper towels to lay the population pyramids on. Encourage students to open up their napkin and place their pyramids one square of their napkin so they will have room for the 'new' population pyramid.

Students will have a variety of population pyramids and this is food for discussion; explore reasons why some populations have many young children or a large elderly population. What situations could account for a population pyramid with a specific shape? What predictions could a student make about the history of their Jellybean country? Eating the jellybeans afterwards is up to you. Beads can also be used for this activity -- be sure to find 10 colors. I thought about using different fruits and vegetables to make a big pyramid as a demo- could lead to a discussion of healthy food as well! The chapter online below is a good follow up- I would suggest a Cornell note outline where the students would use graphs to pictorially represent the information. Please reformat the worksheet below to leave room for answers.

Jellybean Country

Name ___________

Many factors influence the growth or decline of populations. As the size of a social group increases, so may its influence on society. In this activity, you will look at different age groups with in a population forming a population pyramid. Then you will explore a change in your population pyramid and work out reasons why such a change would take place. Lastly, you will predict the future of your population if current conditions remain the same.

Name of my country ______________________________________

Obtain a sample of 50 multi-colored “organisms”. Organize your population by color, horizontally, as follows

		# of people	% of population
Row 8 -Above this line put all other colors	(Ages70 & up)		
Row 7- Above this line put all reds	(Ages 60-69yr)		
Row 6- Above this line put all blues	(Ages 50-59yr)		
Row 5 - Above this line put all oranges	(Ages 40-49yr)		
Row 4- Above this line put all greens	(Ages 30-39yr)		
Row 3 – Above this line put all pinks	(Ages 18-29yr)		
Row 2 - Above this line put all yellows	(Ages 7-17 yr)		
Row 1 - all or mostly white jelly beans	(Ages 0-6 yr)		

1. Count all rows and determine the % of population [# in row/ 50(total population)]

2. Is the population in your country a developed or underdeveloped country.

Why do you think so?

3. Now, group your population into three age groups as follows

	# in group	% of population	
Children – Ages 0 - 17 yr.			
Workforce – Ages 18 - 59			yr.
Elderly – Ages 60 yr. and			up

4. Assume that 20 years have gone by, move Rows 7 & 8 to the bottom of your pyramid and fill in the chart below

		# of organisms	% of population
Row 8 – Above this line up all blues	(Ages70 & up)		
Row 7- Above this line up all oranges	(Ages 60-69yr)		
Row 6- Above this line up all greens	(Ages 50-59yr)		
Row 5 - Above this line up all pinks	(Ages 40-49yr)		
Row 4- Above this line up all yellows	(Ages 30-39yr)		
Row 3 – Above this line up all whites	(Ages 18-29yr)		
Row 2 - Above this line up other colors	(Ages 7-17yr)		
Row 1 - All reds or mostly reds	(Ages 0-6yr)		

5. What happened to the percentages in your population?

6. Identify three possible influences that would cause this change in your population

7. Predict the changes in your population in another twenty years if current conditions remain the same

II . Building Population Pyramids -- Paper strip population pyramids are made by the students from grouped population data attained from the U.S. Census Bureau. Similar to the activity above, this activity helps students compare populations that are developed and underdevloped. Teachers will need to cut ten different color paper into half in strips. The strips can be bagged individually for each group of students or left for students to obtain in a common area. Students wil also need scissors, metric rulers, paper glue and 8”x11” tag board or construction paper to glue their pyramids on. A display area for all the pyramids will be most helpful for effective comparison and discussion. Teachers will need to divide students into groups so that enough population graphs are made for comparison. Please reformat the activity below to provide room for answers. Teachers may need to adjust the colors according to what they have available for student use.

Building Population Pyramids

Name ________________

You and your partner are responsible for only one set of population data. Your task is to build a population pyramid by age groups according to the colors and parameters assigned. Be sure to pick a scale and measure each strip exactly so that we can use the pyramids for class comparison.

The colors for each age group are as follows;

0-9 yr - purple
10-19 yr - red
20-29 yr - orange
30-39 yr - yellow
40-49 yr - green
50-59 yr - blue
60- 69 yr - white
70-79 yr - light blue
80-89 yr -- light green

Population Pyramids begin with the youngest members at the base and follow in order of age for each layer above. Be sure to make exact measurements to the nearest millimeter before you cut the paper strip- you will not get more paper strips.

For Mexico

Look at the range of the number of people. Can 1000 people = 1 millimeter? Or 1 centimeter? Determine your scale. Write your scale here ______________

For the United States

The range of people in an age bracket is from 9,251,968 (80+ yr in 2000) to 47,466,898 (0-9 yr projected for 2028) Do 1,000,000 people = 1 millimeter?

Write your scale here ________________

1. Can you explain why different scales are necessary?

Build your pyramid according to the data chart given to you year. Be sure to check the year and the total population for each age group.

When your strips are cut and in order, glue them onto your paper and answer the following questions about your pyramid.

Questions about your pyramid

2. What shape is your pyramid?

3. Do you think your country is developed or undeveloped in the year you are graphing?

4. What do you predict will happen to your population in twenty years?

Be sure to give at least two reasons why you think this.

After your teacher has displayed all the population pyramids, answer these questions.

Compare your pyramid with the same year for the other country. Remember the size of the pyramid represents a different number of people by 100, 000.

Aside from this obvious difference;

How are the pyramids alike?

How are they different?

Now look at your country over the twenty-eight year time span. For the country you have explain the changes in population and give at least three reasons for this predicted change in population. Are the numbers of people in the age brackets the same? What is expected to happen by 2028 in your country?

United States	past
Year/2000	Population(mil)
Total, all ages	282,338,631
0-9 yr	39,701,280
10-19 yr	40,858,374
20-29 yr	38,501,880
30-39 yr	43,235,427
40-49 yr	42,765,926
50-59 yr	31,349,767
60-69 yr	25,203,981
70-79 yr	15,876,260
80+ yr	9,251,968

United States	current
Year/2007	Population(mil)
Total, all ages	301,139,947
0-9 yr	40,689,587
10-19 yr	41,906,069
20-29 yr	41,845,637
30-39 yr	40,430,469
40-49 yr	44,726,858
50-59 yr	39,272,026
60-69 yr	25,203,981
70-79 yr	15,876,260
80+ yr	11,189,060

United States	projected
Year/2014	Population(mil)
Total, all ages	319,894,598
0-9 yr	43,616,508
10-19 yr	41,027,484
20-29 yr	44,086,006
30-39 yr	41,968,442
40-49 yr	41,684,966
50-59 yr	43,889,147
60-69 yr	33,125,523
70-79 yr	18,232,391
80+ yr	12,264,131

United States	projected
Year/2028	Population(mil)
Total, all ages	358,088,695
0-9 yr	47,466,898
10-19 yr	46,434,249
20-29 yr	44,942,192
30-39 yr	45,965,074
40-49 yr	44,699,164
50-59 yr	40,099,298
60-69 yr	40,072,504
70-79 yr	30,550,251
80+ yr	17,859,065

Mexico	past
Year 2000	Population(mil)
Total, all ages	99926620
0-9 yr	11259832
10-19 yr	10610492
20-29 yr	13991194
30-39 yr	10974405
40-49 yr	7702320
50-59 yr	4920846
60-69 yr	2442141
70-70 yr	1351892
80+ yr	997018

Mexico	current
Year 2007	Population(mil)
Total, all	108700891
0-9 yr	10824858
10-19 yr	10858650
20-29 yr	14324050
30-39 yr	12643093
40-49 yr	9611765
50-59 yr	6296375
60-69 yr	4012447
70-70 yr	2265938
80+ yr	1318437

Mexico	Projected
Year 2014	Population(mil)
Total, all	117459365
0-9 yr	10548675
10-19 yr	10651761
20-29 yr	15142985
30-39 yr	13182536
40-49 yr	11524534
50-59 yr	8339238
60-69 yr	4967799
70-70 yr	2428937
80+ yr	1817993

Mexico	projected
Year 2028	Population(mil)
Total, all	133261803
0-9 yr	10151420
10-19 yr	10171799
20-29 yr	14842362
30-39 yr	14648485
40-49 yr	13244521
50-59 yr	11761120
60-69 yr	8587016
70-70 yr	4923179
80+ yr	3299143

III. How it is done?- instructions for making a presentation

Email beitlerbiologyyahoo.com for a presentation on how to use presentation software to make a presentation.

IV. State embedded task; Human Population Dynamics teacher and student instructions are found at http://www.sde.ct.gov/sde/cwp/view.asp?a=2618&q=320892 - The task has students create a presentation after examining and interpreting data from the U.S. Census Bureau.

RUBRIC for Grading *Population Dynamics* –Due _________ Name _________________

- ☐ Do I have a Title slide with my name and period? 5 pts
- ☐ Have I defined what developed and undeveloped countries are? 10 pts
- ☐ Have I found an underdeveloped country's population pyramids? 5 pts
- ☐ Can I compare the 2005 results with the 2025 projected results? 10 pts
- ☐ Have I found a developed country's population pyramids? 5 pts
- ☐ Can I compare the 2005 results with the 2025 projected results? 10 pts
- ☐ Have I compared a developed with an undeveloped country? 10 pts
- ☐ Can I identify at least three trends in population growth? 10 pts
- ☐ Can I identify reasons for changes in population growth? 10 pts
- ☐ Have I projected the introduction of technology into an undeveloped country? 10 pts
- ☐ Do I have 6-10 power point slides? 5 pts
- ☐ Do I have a resource slide in APA format? 5 pts
- ☐ APA Format: Last name of author, First initial. Year. Title of article. Title of publication. Retrieved date from web address. 5pts

_______________ of 100 pts

Lesson Plan 4 -- Data collection and display

I. Methods of data presentation- *Graphs & Data Display* . Edward Tufte provides extensive data interpretation. Books, graphs, picture and an informative forum can be found at http://www.edwardtufte.com/tufte/. Hans Rosling gives an interesting and entertaining talk that can be found at http://www.ted.com/index.php/talks/hans_rosling_shows_the_best_stats_you_ve_ever_seen.html using fun graphics to show how countries have changed and grown since the 1970's. Mr. Rosling visually shows how money and health care affect population survival and the problems with averaging data when making generalizations about countries. He also promotes making world data available and searchable to everyone. Steve Levitt tells his 'fairy tale" and shows data and graphs on the use of car seats versus seat belts for children over two years old found at http://www.ted.com/index.php/talks/steven_levitt_on_child_carseats.html. Al Gore gives 15 Ways to Avert the Climate Crisis at http://www.ted.com/index.php/talks/al_gore_on_averting_climate_crisis.html these can all be found at TED.com and are approximately 20 minutes each in length. Each video clip demonstrates a lead in to how data can be used in industry and leads to a discussion of careers in data and graphic display.

II. Using *IDKT!* for final assessment for the unit -- A numerical grading system can be applied; Zero, student had no knowledge of the objective. One, student had limited or erroneous knowledge of the objective. Two, student had some knowledge of the objective. Three, student had good knowledge of the subject matter. Using this system a student would receive a zero to three on each of the sections of the *IDKT!* sheet (prior knowledge, learned knowledge and ability to ask questions) for a possible total of nine points, awarded daily. A chart kept in the room would provide students the data to graphically display how their knowledge grew, or students could keep individual charts to display and explain their own growth.