PA – 3 Region
Mathematics and Science Partnership

UNIT #1 TITLE: Good, Better, Best: Data Analysis, Predictions, Applications

For use with grades: 9-12

Developed by:

- Valerie Guiseppe
- Jennifer Hoskins
- Deborah Atkins

ROLES AND RESPONSIBILITIES

TEAM NAME: Octorara Area High School

Team Member	Role	Responsibilities
Deb Atkins	Algebra 2	Assemble unit, film as needed
Jen Hoskins	Statistics	Research NASA resources
Val Guiseppe	Biology	Check standards, anchors

Unit #1 Outline

GRADE LEVEL(S):
9-12
PA COMMON CORE – MATH OR NATIONAL SCIENCE STANDARDS:
National Science Standards **A. Science as Inquiry -** Science as inquiry requires students to combine processes and scientific knowledge with scientific reasoning and critical thinking to develop their understanding of science. **E. Science and Technology -** An understanding of science and technology establishes connections between the natural and designed world, linking science and technology. **U. Unifying Concepts and Processes -** Unifying concepts and processes help students think about and integrate a range of basic ideas which builds an understanding of the natural world. **H.U.2** Evidence, models, and explanation **Science Standard 15, Grades 3-5** *Knows that scientific investigations involve asking and answering a question and comparing the answer to what scientists already know about the world* **Science Standard 15, Grades 6-8** *Establishes relationships based on evidence and logical argument (e.g., provides causes for effects)* *Knows that scientific inquiry includes evaluating results of scientific investigations, experiments, observations, theoretical and mathematical models, and explanations proposed by other scientists (e.g., reviewing experimental procedures, examining evidence, identifying faulty reasoning, identifying statements that go beyond the evidence* **Science Standard 15, Grades 9-12** *Knows that a wide range of natural occurrences may be observed to discern patterns when conditions of an investigation cannot be controlled* *Uses technology (e.g., hand tools, measuring instruments, calculators, computers) and mathematics (e.g., measurement, formulas, charts, graphs) to perform accurate scientific investigations and communications* **Science Standard 16, Grades 3-5** *Knows that although people using scientific inquiry have learned much about the objects, events, and phenomena in nature, science is an ongoing process and will never be finished* **Common Core Math Standards** **CC.2.4.HS.B.2** Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data. **2.5.A1.A:** Develop a plan to analyze a problem, identify the information needed to solve the problem, carry out the plan, check whether an answer makes sense, and explain how the problem was solved in grade appropriate contexts.

2.5.A1.B: Use symbols, mathematical terminology, standard notation, mathematical rules, graphing, and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas, and results.
2.6.A2.C: Construct a line of best fit and calculate its equation for linear [and non Linear] two-variable data
A2.2.3.1: Analyze and/or interpret data on a scatter plot and/or use a scatter plot to make predictions.

ASSESSMENT ANCHORS:

PA Common Core – Biology Anchors
BIO.A.1.2 Describe relationships between structure and function at biological levels of organization.
BIO.A.4.2 Explain mechanisms that permit organisms to maintain biological balance between their internal and external environments.

ESSENTIAL QUESTION:
(DEVELOP A GLOBAL QUESTION THE UNIT IS DESIGNED TO ADDRESS)

How do science and math use data to make predictions and answer questions about real world applications? How does this information improve current conditions?

UNIT OBJECTIVES:

Describe and explain data, observations of a process relative to current knowledge.

GENERAL MATERIALS NEEDED FOR UNIT: (include technology, NASA resources, etc…)

Bones, meter sticks, laptops, anatomical models, TI-84, assorted websites (NASA, GISS, ESA, etc), articles

MODELING AND GUIDED INSTRUCTION: (the whole class will be involved in the following learning experience)
Videos, PowerPoint, discussion of principles and concepts, notes, diagrams
COLLABORATION/GROUP WORK: (problem-based/inquiry learning)
Data collection, interpretation of functions and observations, research
INDEPENDENT PRACTICE: (student exploration and elaboration)
read/outline content from book, investigate posed questions, find real world examples
ASSESMENT/EVALUATION: (authentic student products and how assessed)
Formative: Review lab reports Student presentation of results
Summative: Propose solutions (practical solution to real world problem or condition)

Lesson Plan #1 – Unit #1

Author: Valerie Guiseppe, Octorara Area Junior Senior High School
Grade Level: High School 11-12

Topic/Title: *Earth and Space Physiology: The Skeletal System - Predicting Height*

Standards: Math - PA Common Core; Science - National Standards

PA Common Core – Biology Anchors

BIO.A.1.2 Describe relationships between structure and function at biological levels of organization.
BIO.A.4.2 Explain mechanisms that permit organisms to maintain biological balance between their internal and external environments.

National Science Standards

A. Science as Inquiry - Science as inquiry requires students to combine processes and scientific knowledge with scientific reasoning and critical thinking to develop their understanding of science.
E. Science and Technology - An understanding of science and technology establishes connections between the natural and designed world, linking science and technology.

Objectives:

Students will;

- examine *Ossification Timetable* in humans
- determine procedure to use to obtain anatomical data
- identify the relationship between measurements of the height and femur length for men and women.
- demonstrate the linear relationship of collected data
- predict height from length of limb bones
- describe the application of this scientific process to anthropology and forensic science
- specify potential sources of error

Materials:

www.nsbri.org/HumanPhysSpace/
student investigation 6.1
tape measures, rulers, yard sticks. (English Measurement)
Graph paper
Skeleton – humerus, femur
Anatomy and Physiology Textbook
Skeletal System Diagrams

Anticipatory Set:

Introduce students to space as a laboratory for life sciences. Provide history of orbital flight that included living creatures to study of physiological responses to the stresses of take off, splash down, zero gravity, acceleration G forces.

General group discussion - how "space physiology" lessons may enrich our knowledge and application to "earth physiology" ,

Specific group discussion – Space and Earth physiology of the Skeletal System

Activities: (modeling, guided practice, independent practice & group work)

Research – Online www.nsbri.org/HumanPhysSpace/indexb.html **Human Physiology in Space** **Focus 6: Skeletal System** - Examining Effects of Space Flight on the Skeletal System Earth Physiology Space Physiology **Modeling** – examine skeleton. Identify anatomical features of leg and arm long bones. **Group Work - S11: Predicting Height from Length of Limb Bones** Define process to acquire data from the class' defined population. **Guided Practice – Graph Data: slope, equation of a line y = mx + b**
Wrap-up:
• Compare group results • Specify potential sources of error • Describe the application of this scientific process to anthropology and forensic science
Evaluation / Assessment:
Provide written documentation of student investigation activity that demonstrates how bone growth characteristics relate to overall skeletal structure, specifically height. (lab report)

Lesson Plan #1 – Unit #1

Author: Jennifer Hoskins **Grade Level: 11, 12**
Topic/Title: Regression
Standards: Math - PA Common Core
CC.2.4.HS.B.2 Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data.
Objectives:
• To explain what is meant by the direction, form and strength of the overall pattern of a scatter plot. • To define the correlation coefficient, *r*, and describe what it measures. • To write a regression equation and interpret the meaning of the slope and *y*-intercept in context of the problem; •To explain what is meant by extrapolation and interpret a situation where extrapolation occurs; • To make predictions based on the correct mathematical model. • To plot residuals and interpret their graphical form.
Materials:
Olympics 100 Meter Dash Video http://www.nytimes.com/interactive/2012/08/05/sports/olympics/the-100-meter-dash-one-race-every-medalist-ever.html/ Teacher Notes and Data included in this document **Space Walk Training Activity** Link to Activity http://www.nasa.gov/audience/foreducators/mathandscience/research/Prob_SpacewalkTrain_detail.html **Using Simple Linear Regression to Assess the Success of the Montreal Protocol in Reducing Atmospheric Chlorofluorocarbons(Dean Nelson, University of Pittsburg at Greensburg)** Link to Activity http://www.amstat.org/publications/jse/v17n2/nelson.html#Figure1

Anticipatory Set:
View the video from the New York Times about the Olympic 100 meter dash. http://www.nytimes.com/interactive/2012/08/05/sports/olympics/the-100-meter-dash-one-race-every-medalist-ever.html/ Stop the video at "What can we take away from this…." Use the teachers notes to initiate a discussion and use the video as a hook to move into a lesson about regression.
Activities: (modeling, guided practice, independent practice & group work)
Task 1: Students will investigate the men's and women's data on the Olympic 100 meter dash. They will make models and predictions about the data. In addition, they will compare the men and women's data for similarities and differences. **Task 2:** Students will use the Space Training Activity to evaluate pressures experienced by astronauts and scuba divers who assist them in training in the Neutral Buoyancy Laboratory. **Task 3:** Students will use linear regression to evaluate the effect of the Montreal Protocol on atmospheric concentration of chlorofluorocarbons. This simple set of data, obtained from a public archive, can be used to tell a compelling story of success in international diplomacy solving a global environmental problem.
Wrap-up:
Students will make predictions about what the current levels of CFCs should be based on their models.
Evaluation / Assessment:
Students will present their models and will check the current levels of CFCs to check the accuracy of their models. ftp://ftp.cmdl.noaa.gov/hats/cfcs/cfc11/combined/HATS_global_F11.txt

Teacher Notes for Olympic 100 Meter Dash Activity

video

http://www.nytimes.com/interactive/2012/08/05/sports/olympics/the-100-meter-dash-one-race-every-medalist-ever.html/

Stop the video at "What can we take away from this…."

Questions

1. List 3 things that you notice.
2. List 3 things that you wonder about?

Short discussion…. Each group tells one thing
Finish video
Optional more discussion

Trends

1. Show the Men's data. Can this trend continue? Why or why not?
2. How can we make a model? (what kind….)

3. Make a graph/model of the men's data. What scale????? Start at zero?
4. Predict the war-time times. 1916, 1940,1944

Compare

1. Show women's data
2. Show the comparison.
3. What are some similarities and differences that you notice?
4. Will the women ever run as fast as the men? How can we check?

Mens 100 Meter Olympic Data

1896	Thomas Burke, United States	12
1900	Francis W. Jarvis, United States	10.8
1904	Archie Hahn, United States	11
1906	Archie Hahn, United States	11.2
1908	Reginald Walker, South Africa	10.8
1912	Ralph Craig, United States	10.8
1920	Charles Paddock, United States	10.8
1924	Harold Abrahams, Great Britain	10.6
1928	Percy Williams, Canada	10.8
1932	Eddie Tolan, United States	10.3
1936	Jesse Owens, United States	10.3
1948	Harrison Dillard, United States	10.3
1952	Lindy Remigino, United States	10.4
1956	Bobby Morrow, United States	10.5
1960	Armin Hary, Germany	10.2
1964	Robert Hayes, United States	10
1968	James Hines, United States	9.9
1972	Valery Borzow, USSR	10.14
1976	Hasely Crawford, Trinidad and Tobago	10.06
1980	Allan Wells, Britain	10.25
1984	Carl Lewis, United States	9.99
1988	Carl Lewis, United States	9.92
1992	Linford Christie, Great Britain	9.96
1996	Donovan Bailey, Canada	9.84
2000	Maurice Greene, United States	9.87
2004	Justin Gatlin, United States	9.85
2008	Usain Bolt, Jamaica	9.69
2012	Usain Bolt, Jamaica	9.63

Women's 100 Meter Olympic data

1928	Elizabeth Robinson, United States	12.2
1932	Stella Walsh, Poland	11.9
1936	Helen Stephens, United States	11.5
1948	Fanny Blankers-Koen, Netherlands	11.9
1952	Marjorie Jackson, Australia	11.5
1956	Betty Cuthbert, Australia	11.5
1960	Wilma Rudolph, United States	11
1964	Wyomia Tyus, United States	11.4
1968	Wyomia Tyus, United States	11
1972	Renate Stecher, East Germany	11.07
1976	Annegret Richter, West Germany	11.08
1980	Lyudmila Kondratyeva, USSR	11.06
1984	Evelyn Ashford, United States	10.97
1988	Florence Griffith-Joyner, United States	10.54
1992	Gail Devers, United States	10.82
1996	Gail Devers, United States	10.94
2000	Marion Jones, United States	10.75
2004	Yuliya Nesterenko, Belarus	10.93
2008	Shelly-Ann Frazer	10.78
2012	Shelly-Ann Frazer-Pryce	10.75

Lesson Plan #1 – Unit #1

Author: Deb Atkins **Grade Level: 9-12 Algebra, PreCalculus**
Topic/Title: Mine Fits Best! Modeling Linear Data
Standards: Math - PA Common Core; Science - National Standards
2.5.A1.A: Develop a plan to analyze a problem, identify the information needed to solve the problem, carry out the plan, check whether an answer makes sense, and explain how the problem was solved in grade appropriate contexts. **2.5.A1.B:** Use symbols, mathematical terminology, standard notation, mathematical rules, graphing, and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas, and results. **2.6.A2.C:** Construct a line of best fit and calculate its equation for linear [and non Linear] two-variable data **A2.2.3.1:** Analyze and/or interpret data on a scatter plot and/or use a scatter plot to make predictions.
Objectives:
• Students will be able to model a scenario to collect data. • Students will be able to create a linear model using real data. • Students will be able to make a prediction using a linear model.
Materials:
Lengths of clothesline (< arm's length), tape measure Barbies, rubber bands (lots of rubber bands!) Graph paper, graphing calculator Activity worksheets
Anticipatory Set:
Essential questions: • How can expressions and equations be used to represent practical problems? • How can identifying and using patterns help us to solve these problems?

Activities: (modeling, guided practice, independent practice & group work)
1. **Tie the Knot—**students collect date using clothesline, create scatterplot, draw best fit line, create model (equation) 2. **Space Shuttle Ascent**-- http://www.nasa.gov/pdf/264012main_Algebra_Stu_Shuttle.pdf Students use data to create graph, draw best fit line, model, use TI-8* to find linear regression (LinReg) equation, compare
Wrap-up:
Knot Right?—students use knot data and LinReg to make comparison, summarize Where/how are linear models used to make predictions? What are some authentic applications (scenarios) for linear models?
Evaluation / Assessment:
Bungee Barbie activity—includes data collection, line of best fit, linear regression, summary

Tie the Knot: Linear Regression Activity

Procedure

1. Measure the length of the unknotted piece of rope to the nearest tenth of a **centimeter**. Enter the data in the chart below.

   - What must be considered? ____________________
   - What decision must be made to standardize the data? __________________
   - Must the class agree, or can groups decide differently? _________________

2. Tie a knot in the rope and measure the length of the rope again. Record your results in the chart.
3. Repeat step 2 until it is not practical to tie more knots in the rope.

Knots	Length of Rope (cm)

Investigation

1. Examining the data in the chart, what do you notice about length of the rope as you tie each knot?

2. What is associated with the x-axis? The *y-axis*? Does it matter which is which?

3. **Graph** the data and draw the line that best represents your data.

4. Find the **slope** of the line. What does this represent? **Slope: ______________**

Represents--

5. Find the y-**intercept**. What does it mean? **y-intercept: __________**

Means--

6. Write the equation of the line. **Equation : _________________________________**

7. Using the equation you found, **predict** how long the rope would be after 25 knots. Does your answer make sense?

With 25 knots, I predict my rope will be ____________ inches long.

8. Write two questions about the number of knots or the length of your rope that could be answered using your linear model. Answer the two questions.

9. Find another group and compare equations. List the names of those in the group and their equation. What do you observe? Are the equations similar? Should they be? Why or why not?

(after Space shuttle activity)

10. Use the graphing calculator to find the linear regression line for your data. Graph this line.

How do the two lines compare? ____

____

The calculator equation is y = ____ x + ______

My best-fit equation is y = ____ x + ______

What do you notice about the slopes? ____

What do you notice about the y-intercepts? ____________________________________

Which model do you think is better? ____________________

Why? ____

____

11. Summarize this activity by writing an essay as outlined below.

1st paragraph: introduce the activity and purpose
2nd paragraph: briefly describe what you did
3rd paragraph: describe the results; include your observations
4th paragraph: How is the activity like anything else you have done? What are the applications/implications? (remember the purpose)
5th paragraph: State your conclusions.

Exploring Space Through ALGEBRA

STUDENT EDITION

Algebra I

Space Shuttle Ascent

Background

Exploration provides the foundation of our knowledge, technology, resources, and inspiration. It seeks answers to fundamental questions about our existence, responds to recent discoveries and puts in place revolutionary techniques and capabilities to inspire our nation, the world, and the next generation. Through NASA, we touch the unknown, we learn and we understand. As we take our first steps toward sustaining a human presence in the solar system, we can look forward to far-off visions of the past becoming realities of the future.

The Vision for Space Exploration includes returning the space shuttle safely to flight, completing the International Space Station, developing a new exploration vehicle and all the systems needed for embarking on extended missions to the Moon, Mars, and beyond.

Since its first flight in 1981, the space shuttle has been used to extend research, repair satellites, and help with building the International Space Station, or ISS. However, by 2010 NASA plans to retire the space shuttle in favor of a new Crew Exploration Vehicle, or CEV. Until then, space exploration depends on the continued success of space shuttle missions. Critical to any space shuttle mission is the ascent into space.

The ascent phase begins at liftoff and ends at insertion into a circular or elliptical orbit around the Earth. To reach the minimum altitude required to orbit the Earth, the space shuttle must accelerate from zero to 8000 meters per second (almost 18,000 miles per hour) in eight and a half minutes. It takes a very unique vehicle to accomplish this.

Figure 1: Space Shuttle Discovery at Liftoff

Full activity available at http://www.nasa.gov/pdf/264012main_Algebra_Stu_Shuttle.pdf

Students view video, review background information, complete questions, graph data provided, model data, calculate linear regression

Bungee Barbie

Adapted from an activity by Dr. John C. Uccellini (who adapted it from someone else…)

Length of activity: 3 days

Standards addressed: linear modeling, data analysis

Purpose:

The object of this activity is to take Barbie bungee jumping and provide her with the greatest thrill possible without endangering her life. To prepare for the big day your group will **collect practice jump data** on the distance Barbie falls using a rubber band bungee cord. The goal is to **determine the number of rubber bands** necessary to allow Barbie to jump from an unknown height and get as close to the ground as possible without hitting her head. The jump distance will be a closely guarded secret until the day of the jump. You must make your best determination of the number of rubber bands that will be required based on your **analysis of** the practice jump **data** that your group collected, and an estimation of the platform's height. You will be graded on the thoroughness of the completion of the requirements. Also, you and your group will have the opportunity to compete for bonus points by having Barbie make the longest jump from the platform without hitting her head on the ground.

Directions:

- Assemble materials: a Barbie doll, a bag of rubber bands, tape measure, a data collection sheet.
- Collect as much data as possible in the time provided on the length of Barbie's bungee jumps as you vary the number of rubber bands making up the chord.
- Record your data on the data collection sheet.
- Construct a graph of the data collected.
- Develop a mathematical model that best represents the jump data. The model will be used to determine how many rubber bands it take to give Barbie a safe but thrilling jump from a platform of given height.
- On day 3 the class will be taken to a location with a high drop point. Each group must determine the correct number of rubber bands to allow Barbie to get closer to the ground than any other group. Every group may have a **second chance** to allow Barbie to re-jump. ***Remember: if Barbie's head touches the ground, she is dead, and that group is disqualified from the competition***.
- Complete an activity write-up summarizing the process that you used to develop your mathematical model. Be sure to discuss the factors that influenced your model.

Grading:

Students will be graded as a group and individually.

- Your group grade will be based on your group's successful completion of the activity: data collection, cooperation, organization, and behavior.
- Your individual grade will be based on the quality of all written work: data, graph, calculations, and **TYPED** summary.

Bonus:

Each class will compete for 5 bonus points. The group with the best results will receive a 5 point bonus. The group with the best jump results (Barbie is closest to the floor but doesn't hit her head) will be the "winners."

BUNGEE BARBIE DATA COLLECTION WORKSHEET
Be sure to **gather enough data** to make a reasonably accurate **prediction**.

Trial (Jump) Number	Number of Rubber Bands	Length of Jump
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

REMEMBER: ALL OF THE CALCULATIONS FOR RESPONSES BELOW WILL BE CLEARLY DESCRIBED ON A SEPARATE PAPER.

- **Construct a graph** of your data on graph paper. (This will be attached as part of your work.)

- **Create a mathematical model** (equation) of your data. Use the graph, the LinReg on the calculator, to guide your thinking. Be prepared to describe how you developed your model.

  From graph:_______________________________________

  From LinReg : _____________________________________

  Our Model: "We decided to use
  ______________________________ because _______________________________________

- **Answer** the following questions:

  What are the independent and dependent variables? Ind: _____________ Dep: ______________

  What is your hypothesis?

  "For every _____ rubber bands Barbie falls _______ inches."

  What are your model's slope and y-intercept? What do they each represent **in this scenario**?

  Slope: __________ represents _______________________

  y-intercept: ________ represents _____________________

- **Predict** the number of rubber bands needed for a _________ inch jump. (This part can be completed only **after** you are told the height of the platform from which Barbie will jump.) _______ bands

Grading Checklist for Bungee Barbie

	score
This page (48)	
Summary (30)	
Team points (22)	
Total (100)	

_____ Follow all instructions correctly.

_____ Choose an appropriate title.

_____ State the problem as a question.

_____ Write a hypothesis.

_____ List the variables. What are the independent and the dependent variables?

_____ List the materials and equipment.

_____ Describe the experiment.

_____ Complete the data collection chart correctly, neatly. Include units.

_____ Graph data accurately.

_____ Graph has title, labels, appropriate scale.

_____ Find the equation. Explain what it means.

_____ All calculations are shown neatly and clearly ON A SEPARATE PAGE.

_____ Write a conclusion.

_____ Summarize the activity using 5-paragraph essay format. TYPED.

Data Collection Chart	Graph	Calculations
€ 5 or more trials	€ Title	€ Calculation for slope—**work shown**
€ Clear, neat	€ Axes labeled Scale and units clear, correct	€ Solution for best-fit line—**work shown**
€ Include units	€ Data points graphed correctly	€ Best-fit equation matches line on graph
€ Indicate independent and dependent variable	€ Best-fit line drawn neatly, clearly	€ Calculation for Big Jump—**work shown**
€ ALL questions answered	€ LinReg line drawn neatly, clearly	€ LinReg equation matches line on graph
	€ Each line labeled or key provided	

Lesson Plan #2 – Unit #1

Author: Valerie Guiseppe, Octorara Area Junior-Senior High School, Atglen, PA **Grade Level: 11-12**	
Topic/Title: *Earth and Space Physiology: The Cardiovascular System - Predicting and Managing changes in Blood Pressure*	
Standards: Math - PA Common Core; Science - National Standards:	

PA Common Core – Biology Anchors
BIO.A.1.2 Describe relationships between structure and function at biological levels of organization.
BIO.A.4.2 Explain mechanisms that permit organisms to maintain biological balance between their internal and external environments.
Science National Standards
U. Unifying Concepts and Processes - Unifying concepts and processes help students think about and integrate a range of basic ideas which builds an understanding of the natural world.
H.U.2 Evidence, models, and explanation
a. Evidence–Evidence consists of observations and data on which to base scientific explanations. The goal is to help students use evidence to understand interactions and predict changes.
c. Explanations–Explanations provide interpretation, meaning, or sense to objects, organisms, or events. Explanations incorporate existing scientific knowledge and new evidence from observations, experiments, or models into internally consistent, logical statements, such as hypotheses, laws, principles, and theories. The goal is to help students create explanations which incorporate a scientific knowledge base, logic, and higher levels of analysis.
A. Science as Inquiry - Science as inquiry requires students to combine processes and scientific knowledge with scientific reasoning and critical thinking to develop their understanding of science.
H.A.1 Abilities necessary to do scientific inquiry
a. Identify questions and concepts that guide scientific investigations.
b. Design and conduct scientific investigations.
H.A.2 Understandings about scientific inquiry
a. Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.

Objectives:

Students will;

- Examine cardiovascular system in humans
- Determine cause of blood pressure
- Identify the relationship between experimentation and innovation
- Demonstrate scientific process in recreation of simulation used by NASA scientists
- Predict relationship of physiologic data and blood pressure to prolonged periods of the weightlessness of space travel
- specify potential sources of error
- Describe real world applications of NASA experimentation on weightlessness and blood pressure.

Materials:

Lap tops
Blood pressure cuffs/stethoscopes
Graph paper
Anatomy and Physiology Textbook
Grey's Anatomy (venous structure of legs/arms)
Blankets
Books (to elevate legs)

Anticipatory Set:

Introduce students to space as a laboratory for life sciences. Provide history of orbital flight that included living creatures to study of physiological responses to the stresses of take off, splash down, zero gravity, acceleration G forces.

General group discussion - how "space physiology" lessons may enrich our knowledge and application to "earth physiology" ,

Specific group discussion – Space and Earth physiology of the cardiovascular system. Include terms; orthostatic hypotension, Midodrine

Activities: (modeling, guided practice, independent practice & group work)

1. Research – Online

NASA Science: Science News website:

- **http://science.nasa.gov/science-news/science-at-nasa/2002/25mar_dizzy/** listen to the streaming audio for the article "When space makes you dizzy".

NSBRI National Space Biomedical Research Institute websites:

- **http://www.nsbri.org/projects/indivProject.asp?id=359&projID=33** review article "Computational Models of the Cardiovascular System and its Response to Microgravity

- http://www.nsbri.org/projects/researchPages.asp?id=399&area=earth&TeamID=1 review "Earth applications" summarize ways The Cardiovascular Alternations Team's work benefits health care on Earth

Mars 500 websites:

- http://mars500.imbp.ru/en/index_e.html **exlore the** 520-day isolation simulation completed November 4, 2011. Take the virtual tour Read the experiment " Long-Term control of total Na+ and K+ content and body fluid homeostasis in humans.
- http://mars500.imbp.ru/en/520_sci_experiments/520_Na_K.html and review the experiments simulating aspects of interplanetary manned flight.

2. Group Work - Design experiment to recreate space flight simulation (ie. lying down with head lower than legs). Gather data and report on physiologic changes to blood pressure during experiment.

3. Predict the physiologic effects to the cardiovascular system experienced during extended periods of the weightlessness of space travel

Wrap-up:

- Compare group results
- Specify potential sources of error
- Describe the application of this scientific process to current medical care and treatment considerations

Evaluation / Assessment:

- Provide written documentation of student investigation and experimentation activities that summarizes changes in human physiology during periods of weightlessness and periods of extended inactivity affect blood pressure. Propose suggestions to remediate change in respect to managing prolonged periods of space travel and relate it to real world patient inactivity that may be caused by aging, medical trama, etc.

Lesson Plan #2 – Unit #1

Author: Jennifer Hoskins

Grade Level: 11, 12

Topic/Title: Regression Analysis for Global Warming

Standards: Math - PA Common Core

CC.2.4.HS.B.2
Summarize, represent, and interpret data on two categorical and quantitative variables.

CC.2.4.HS.B.3
Analyze linear models to make interpretations based on the data.

Objectives:

- To explain what is meant by the direction, form and strength of the overall pattern of a scatter plot.
- To define the correlation coefficient, *r*, and describe what it measures.
- To write a regression equation and interpret the meaning of the slope and *y*-intercept in context of the problem;
- To make predictions based on the correct mathematical model.
- To create multiple regression models to determine the best model.
- To compare models for strength using statistical analysis.

Materials:

Global Warming Temperature Activity

Pre-Activity Video
http://www.youtube.com/watch?v=3VBv7q3pnAg&feature=fvwrel

Student Worksheet included in this document

Declining Ice-Cap Analysis

Pre-Activity Videos
http://www.youtube.com/watch?v=b4QjyrGkaUg&feature=related

http://www.youtube.com/watch?v=-8bHufxbxc8

Link to Activity
http://spacemath.gsfc.nasa.gov/weekly/8Page19.pdf

Anticipatory Set:

View the video **NASA - Global Warming timelapse (1884-2011)**
http://www.youtube.com/watch?v=3VBv7q3pnAg&feature=fvwrel

Ask students what the clip is showing.
We will be looking at actual temperature data to make predictions about what is occurring globally.

Activities: (modeling, guided practice, independent practice & group work)

Task 1: Global Warming Activity(See Below)
Students will use linear regression to evaluate the Means Based on Land-Surface Air Temperature Anomalies.This set of data, obtained from a NASA archive, can be used to determine how the earth's climate has varied over the past 200 years.

Task 2: Declining Arctic Ice Cap During September Activity(link above)
View the 2 videos:(links above)
Dramatic Greenland Ice melt
NASA Time-lapse Satellite Imagery of Arctic Ice Cap Melt
Students will use the Declining Arctic Ice Cap During September worksheet to create multiple regression models to determine the best model for making predictions about the polar Ice Melt.

Wrap-up:

- Students will answer the following:
  Based on the Polar Ice Cap Model, when will the polar ice caps be melted?
- Students will research when scientists are saying the polar ice caps will be gone to compare with the models they made.
- Students will research a theory that claims global warming is not occurring.

Evaluation / Assessment:

Students will present their findings to the class.

Global Warming Temperature Activity

The data we will be using for the lab is available online at

http://data.giss.nasa.gov/gistemp/.

Scroll down to the section for Means Based on Land-Surface Air Temperature Anomalies Only (Meteorological Station Data, dT_s)

We will use the Zonal Annual Means

Before we analyze any data, it is important to understand where it comes from and how it is presented. Explore the website (and other sites if you like) and answer the following questions as best you can.

1) Who collected this data?
2) What methods did they use?
3) Is this data raw or processed? If processed, what was done?
4) This data set is presented using temperature anomalies. What is a temperature anomaly? Why did these researchers choose to use anomalies rather than absolute temperatures?
5) What questions do you still have about this data?
6) Where could you search for answers to those questions?

Organize the data

1) You don't need the information above and below the data table for now, but you might want to look at it later. Select the rows containing all of the information above the table except for the first line. Right click and select hide to hide those rows. Do the same with all of the information below the table. Look at the row numbers on the left. The numbers skip to remind you that there are hidden rows, and you can unhide them later if you need them.
2) When you paste a text file into Excel, all of the data often goes into the first column. Before you can analyze it, you need each data point in its own box. To do that, select the first column of all of the data, including the header but not the top row of text information. Under the data tab at the top of the screen, click on Text to Columns. Check to make sure the default options are appropriate for your data and it is being separated in ways that make sense. When you are happy with how it is presented, click finish.
3) The data is divided into blocks of 20 years and the column header is repeated between each block. There are easier ways to view the headers, so you don't need those extra rows. Scroll down through your data and delete all the blank rows and header rows except the one at the top. The last column is a duplicate of the row header, so delete that as well.
4) Bold the headers that you have left (row and column) so that they are easier to see.

Analyze the Data

1. Create a scatter plot for Global Average vs. Year
   - Add a trend line. Be certain to include the equation and the coefficient of determination on the graph.
   - Write the equation in the context of the problem.
   - What does the slope represent in this context?
   - What does the y-intercept represent in this context?
   - What is the strength of this model? Explain.

2. Create a scatter plot for Northern Hemisphere vs. Year
   - Add a trend line. Be certain to include the equation and the coefficient of determination on the graph.
   - Write the equation in the context of the problem.
   - What does the slope represent in this context?
   - What does the y-intercept represent in this context?
   - What is the strength of this model? Explain.

3. Create a scatter plot for Southern Hemisphere vs. Year
   - Add a trend line. Be certain to include the equation and the coefficient of determination on the graph.
   - Write the equation in the context of the problem.
   - What does the slope represent in this context?
   - What does the y-intercept represent in this context?
   - What is the strength of this model? Explain.

4. Compare the three graphs
   - Which model is the strongest and why?
   - How does the rate of climate change vary with time?
   - Is there more change in the Northern Hemisphere or in the Southern Hemisphere? Explain.

Lesson Plan #2 – Unit #1

Author: Deborah Atkins

Grade Level: 9-11

Topic/Title: The Rise and Fall of Greenhouse Gases: Model Data, Make Predictions

Standards: Math - PA Common Core; Science - National Standards:

2.5.A1.A: Develop a plan to analyze a problem, identify the information needed to solve the problem, carry out the plan, check whether an answer makes sense, and explain how the problem was solved in grade appropriate contexts.
2.5.A1.B: Use symbols, mathematical terminology, standard notation, mathematical rules, graphing, and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas, and results.
2.6.A2.C: Construct a line of best fit and calculate its equation for linear [and non Linear] two-variable data
A2.2.3.1: Analyze and/or interpret data on a scatter plot and/or use a scatter plot to make predictions.
CC.2.4.HS.B.2
Summarize, represent, and interpret data on two categorical and quantitative variables.
CC.2.4.HS.B.3
Analyze linear models to make interpretations based on the data.
CC.2.2.HS.C.6
Interpret functions in terms of the situation they model.
CC.2.2.HS.C.5
Construct and compare linear, quadratic and/or exponential models to solve problems.

Objectives:

Recent data on the concentrations of various greenhouse gases in Earth's atmosphere will be plotted by the students. They will look for trends in the data.

Students will be able to analyze data for patterns and make predictions.
Students will evaluate accuracy of model using updated information.
Students will discuss pro/con global warming using prediction model.

Materials:

Online articles (back up hard copies)
Graph paper, ruler, software or calculator for calculations and regression analysis

Anticipatory Set:
Students read and review articles online from The Daily Mail, "Global warming stopped 16 years ago…" and "Greenhouse gases reached record levels…" http://www.dailymail.co.uk/sciencetech/article-2217286/Global-warming-stopped-16-years-ago-reveals-Met-Office-report-quietly-released--chart-prove-it.html http://www.dailymail.co.uk/sciencetech/article-2236311/Greenhouse-gases-reached-record-levels-2011-prompting-warning-global-warming-worse.html **EQ:** What facts should be considered to determine if global warming is occurring?
Activities: (modeling, guided practice, independent practice & group work)
Students have had prior experience modeling data Source for PDF file of activity: http://er.jsc.nasa.gov/seh/Ocean_Planet/activities/ts1pcac1.pdf Students will use data sets to create appropriate model (linear, exponential, quadratic) for greenhouse gases (as assigned to groups) Groups with similar gas data compare models and create consensus model. Check prediction equation with current data, modify if necessary. *Word document follows below for reference…pdf file much better!!*
Wrap-up:
Students present results and prediction model to class. **EQ:** How do choices in displaying data, for example as tables of data or as graphs, affect communication?
Evaluation / Assessment:
1. Poster or Power Point (with notes) for presentation. 2. Summarize class results for all greenhouse gases modeled, explain choice of model, and support own conclusion about the global warming debate using facts presented.

ANALYZING GREENHOUSE GASES AND GLOBAL TEMPERATURE DATA OVER TIME

- Science Standard 15, Grades 3-5

Knows that scientific investigations involve asking and answering a question and comparing the answer to what scientists already know about the world

- Science Standard 15, Grades 6-8

Establishes relationships based on evidence and logical argument (e.g., provides causes for effects)

- Science Standard 15, Grades 6-8

Knows that scientific inquiry includes evaluating results of scientific investigations, experiments, observations, theoretical and mathematical models, and explanations proposed by other scientists (e.g., reviewing experimental procedures, examining evidence, identifying faulty reasoning, identifying statements that go beyond the evidence

- Science Standard 15, Grades 9-12

Knows that a wide range of natural occurrences may be observed to discern patterns when conditions of an investigation cannot be controlled

- Science Standard 15, Grades 9-12

Uses technology (e.g., hand tools, measuring instruments, calculators, computers) and mathematics (e.g., measurement, formulas, charts, graphs) to perform accurate scientific investigations and communications

- Science Standard 16, Grades 3-5

Knows that although people using scientific inquiry have learned much about the objects, events, and phenomena in nature, science is an ongoing process and will never be finished

- Math Standard 6, Grades 9-12

Selects and uses the best method of representing and describing a set of data (e.g., scatter plot, line graph, two-way table)

OVERVIEW

Recent data on the concentrations of various greenhouse gases in Earth's atmosphere will be plotted by the students. They will look for trends in the data.

CONCEPTS

• Plotting data allows us to more easily see trends in the data.
• In the case of data taken over a period of time, graphs also make it easier to see what might occur in the future.
• The quantities of several greenhouse gases are increasing in our atmosphere. The production of
chlorofluorocarbons (CFCs) is now decreasing.

MATERIALS

• Raw Data (attached)
• Pencil
• Graph Paper
• Ruler

PREPARATION

Note that students can plot the data by hand or enter it into appropriate computer software, depending upon the desires of the teacher, equipment available, and level of the students.

Divide the class into small research teams and assign each one a table of data.

PROCEDURE

Engagement

Inform the students that they have been assigned a position in a research institute dealing with global climate issues. A research scientist has just given them some “raw” data regarding greenhouse gases in Earth’s atmosphere. Within a week there will be a major international conference on global change. The data need to be presented and organized in a meaningful and useful way.

Greenhouse gases allow the Sun’s light to pass through them to the surface of Earth, but they also absorb some of the infrared radiation from Earth’s surface. This creates an effect similar to that in a greenhouse. Gases, like glass in a greenhouse, help trap heat and keep it from escaping. There is concern over whether increases in these gases are contributing to global warming. The first step in investigating this is to determine whether amounts of greenhouse gases in the atmosphere have been increasing.

Activity

1. Discuss where data come from, types of graphs available, what a trend is, and how to project a trend.

2. For at least one table of data, have the students plot the following data points, connect them with a curve, and find a linear or exponential or quadratic model that best represents the data. There are four different graphs, therefore make sure that all four are assigned so that each can be discussed.

3. Upon completion of the graph(s) have the students project the trend of the curve for another 50 years.

4. Have each group develop a conclusion for their particular chart. Students with the same graph should get together and compare graphs and models for accuracy and conclusions.

5. Ask for a spokesperson for each graph to report a majority view and a minority view (if one exists) for the data and projected trends.

6. Discuss the role of data analysis in scientific research.

Explanation

The graphs indicate the rising trend of several greenhouse gases, which may or may not contribute to global warming. There is much debate among scientists and policy makers over this issue. Note however the decrease in production of CFCs because of an international agreement to reduce their production. CFCs not only are a greenhouse gas, but more significantly damage the earth's ozone layer which protects us from the Sun's harmful ultraviolet light.

EXTENSION

The following is an account of one scientist's study of carbon dioxide concentrations in Earth's atmosphere. Students can read this to better understand how he needed to gather data over many decades in order to recognize and document their trend.

Dr. Charles David Keeling was the geochemist at Scripps Institute of Oceanography who first studied atmospheric carbon dioxide (CO2) in the 1950s. He developed the first manometer to extract and measure CO2 in parts per million (ppm) and set up a measurement facility on Mauna Loa volcano in Hawaii. Air found there has been well mixed in the atmosphere and thus serves as a good example of global average air.

The first decade of his data showed the CO2 levels to be increasing at a rate of 1 ppm each year. After that, data showed that CO2 levels are increasing at a faster pace - about 1.5 ppm per year. In the last 40 years CO2 levels have increased form 315 ppm to 350 ppm. The trend indicates the amount of CO2 in the earth's atmosphere will likely continue its increase.

The amount of CO2 and other greenhouse gases in the atmosphere is increasing in large part due to human activity. Average global temperatures are also increasing. Is there a connection? It is not totally clear yet, but those who believe there is feel that the amount of CO2 being pumped into the atmosphere from human activities should be reduced.

Discuss with your students the types of changes that can be made to reduce CO2 emissions. What is their county, state, or country doing (if anything) to help? Have the students ask older family members or friends about the impact that reducing CFCs has had on their daily lives. Do they feel changing their lifestyle or spending habits to help reduce CO2 is worthwhile?

VOCABULARY

chlorofluorocarbon (CFC)
global warming
greenhouse gas
manometer

SOURCE

Adapted from Global Climate-Past, Present, and Future, S. Henderson et al. (Eds.), Environmental Protection Agency Report No. EPA/600/R126, pp. 77-89.

Carbon Dioxide Concentrations (in ppmv*), Mauna Loa, Hawaii

Year	ppmv
1958	314.8
1959	316.1
1960	317.0
1961	317.7
1962	318.6
1963	319.1
1964	319.4
1965	320.4
1966	321.1
1967	322.0
1968	322.8
1969	324.2
1970	325.5
1971	326.5
1972	327.6
1973	329.8
1974	330.4
1975	331.0
1976	332.1
1977	333.6
1978	335.2
1979	336.5
1980	338.4
1981	339.5
1982	340.8
1983	342.8
1984	344.3
1985	345.7
1986	346.9
1987	348.6
1988	351.2

*ppmv = Parts per million by volume

Methane Gas Concentration

Year	ppm*
1850	0.90
1979	0.93
1880	0.90
1892	0.88
1908	1.00
1917	1.00
1918	1.02
1927	1.03
1929	1.13
1940	1.12
1949	1.18
1950	1.20
1955	1.26
1956	1.30
1957	1.34
1958	1.35
------	-----
1975	1.45
1976	1.47
1977	1.50
1978	1.52
1979	1.55
1980	1.56
1981	1.58
1982	1.60
1983	1.60
1984	1.61
1985	1.62
1986	1.63
1987	1.65
1988	1.67
1989	1.69
1990	1.72

*ppm = Parts per million
Gaps in the record between 1958-1975.

CFC (chlorofluorocarbon) Production

Year	Amount
1955	100
1957	120
1959	140
1961	150
1963	150
1965	200
1967	225
1969	290
1971	320
1973	375
1975	350
1977	360
1979	330
1981	325
1983	320
1985	340
1987	300
1989	305
1991	310

CFCs include the manufactured gas combinations of chlorine, fluorine, and carbon.
These gases were not present in Earth's atmosphere until the 1930's.
Values are in kilotons per year.

Nitrous Oxide

Year	ppbv*
1750	283.0
1760	283.5
1770	284.0
1780	284.5
1790	285.0
1800	285.5
1810	286.0
1820	286.5
1830	287.0
1840	287.5
1850	288.0
1860	288.5
1870	289.0
1880	289.5
1890	290.0
1900	291.0
1910	292.0
1920	292.5
1930	293.0
1940	294.0
1950	295.0
1960	297.0
1970	299.0
1980	305.0
1990	310.0

*Parts per billion by volume (ppbv)

Additional Student Resources

Trends in Atmospheric Carbon dioxide
http://www.esrl.noaa.gov/gmd/ccgg/trends/

CO2 expressed as a mole fraction in dry air, micromol/mol, abbreviated as ppm

# year	mean	unc
1959	315.97	0.12
1960	316.91	0.12
1961	317.64	0.12
1962	318.45	0.12
1963	318.99	0.12
1964	319.62	0.12
1965	320.04	0.12
1966	321.38	0.12
1967	322.16	0.12
1968	323.04	0.12
1969	324.62	0.12
1970	325.68	0.12
1971	326.32	0.12
1972	327.45	0.12
1973	329.68	0.12
1974	330.18	0.12
1975	331.08	0.12
1976	332.05	0.12
1977	333.78	0.12
1978	335.41	0.12
1979	336.78	0.12
1980	338.68	0.12
1981	340.10	0.12
1982	341.44	0.12
1983	343.03	0.12
1984	344.58	0.12
1985	346.04	0.12
1986	347.39	0.12
1987	349.16	0.12
1988	351.56	0.12
1989	353.07	0.12
1990	354.35	0.12
1991	355.57	0.12
1992	356.38	0.12
1993	357.07	0.12
1994	358.82	0.12
1995	360.80	0.12
1996	362.59	0.12
1997	363.71	0.12
1998	366.65	0.12
1999	368.33	0.12
2000	369.52	0.12
2001	371.13	0.12
2002	373.22	0.12
2003	375.77	0.12
2004	377.49	0.12
2005	379.80	0.12
2006	381.90	0.12
2007	383.76	0.12
2008	385.59	0.12
2009	387.38	0.12
2010	389.78	0.12
2011	391.57	0.12

http://www.noaanews.noaa.gov/stories2009/20090421_carbon.html

http://www.esrl.noaa.gov/gmd/aggi/

http://www.noaa.gov/features/02_monitoring/methane.html

http://www.esrl.noaa.gov/gmd/education/faq_cat-3.html

http://www.dnrec.delaware.gov/ClimateChange/Pages/Risingconcentrationofatmosphericgreenhousegases.aspx

NASA-Funded Study Helps Untangle *Methane* Mystery - NASA Jet ...

www.jpl.nasa.gov/news/news.php?release=2012-263
Aug 28, 2012 – The long-term decline of the global *concentration* of *atmospheric* ethane **...** *Atmospheric methane* is 20 times more potent as a greenhouse *gas* **...**

http://www.jpl.nasa.gov/news/news.php?release=2012-263

IMPLEMENTATION PLAN
Unit #1

A. One videotaped lesson is required per unit, saved on CD-ROM (include in CD ROM sleeves in portfolio).

Anticipated Lesson for Taping Skeletal System; Global Warming

Planned Taping date(s) November/December 2012

B. A professional development component is required for each unit. This requirement may be met in any one of the following forms (or another of your choice):

- Professional development training to colleagues

C. Plan of implementation (Meetings, events, etc.): Share lesson topics, connection to common core standards with department. Describe development process, student reaction to applications.

UNIT PROGRESSION FORM: Unit #__1_

Group/Coordinator: Deb Atkins
Date: December 2012

UNIT ASSESSMENT

The degree to which the lesson(s):	√	Write a statement to describe how this item was met.
Identified the prior knowledge required by the students.	√	Developed questions to activate prior knowledge and determined preconceptions by making predictions prior to activity.
Identify and/or provide an authentic real-world problem relevant to the students for them to solve	√	1. Forensic anthropology 2. Global warming 3. Predictions for safety
Was aligned with PA standards.	√	PDESAS—anchors and standards
Followed problem-based/inquiry learning model.	√	5e Instructional model: **Engage, Explore, Explain, Extend** (or **Elaborate**), and **Evaluate.**
Allowed for student exploration and elaboration.	√	Students collected data and investigated accuracy of predictions
Required authentic student products.	√	Students produced written evaluation of activity.
Integrated technology into the lesson(s).	√	Use of graphing technology, statistics software (ex FATHOM), interactive white boards, and traditional measuring tools
Clearly defined how students would be assessed.	√	Established target/objective prior to activity.
Utilized and incorporated NASA resources throughout lesson(s).	√	1.Used nasa.gov education materials as resource for activity 2. Used examples of NASA missions, data for background

GROUP ASSESSMENT (see next page for details)

The group showed:	√	Write a statement to describe how this item was met.
Contributions/participation, Attitude	√	Collaborated on lessons, coteach (biology/algebra) Consulted for ideas to make activities authentic and meaningful
Cooperation/Working with others	√	Awesome team!!
Focus on task/commitment	√	Regular meetings @ PA3; meet at OHS as needed
Team role fulfillment	√	Accountable to each other

Group Signatures: ______________________ **Date:** __________

______________________ **Date:** __________

______________________ **Date:** __________

______________________ **Date:** __________

______________________ **Date:** __________

Group Work Rubric

Team Participant Names: <u>Deborah Atkins, Jennifer Hoskins, Val Guiseppe</u>

Skills	~~Basic~~	~~Sound~~	~~Thorough~~	Extensive
Contributions/participation Attitude	~~Seldom cooperative, rarely offers useful ideas. Is disruptive.~~	~~Sometimes cooperative, sometimes offered useful ideas. Rarely displays positive attitude.~~	~~Cooperative, usually offered useful ideas. Generally displays positive attitude.~~	Always willing to help and do more, routinely offered useful ideas. Always displays positive attitude.
Working with others/cooperation	~~Did not do any work – does not contribute, does not work well with others, usually argues with teammates.~~	~~Could have done more of the work – has difficulty, requires structure, directions and leadership, sometimes argues.~~	~~Did their part of the work – cooperative. Works well with others, rarely argues.~~	Did more than others – highly productive Works extremely well with others, never argues
Focus on task/commitment	~~Often is not a good team member. Does not focus on the task and what needs to be done. Lets others do the work.~~	~~Sometimes not a good team member. Sometimes focuses on the task and what needs to be done. Must be prodded and reminded to keep on task.~~	~~Does not cause problems in the group. Focuses on the task and what needs to be done most of the time. Can count on this person.~~	Tries to keep people working together. Almost always focused on the task and what needs to be done. Is very self-directed.
Team role fulfillment	~~Participate in few or no group meetings. Provided no leadership. Did little or no work assigned by the group.~~	~~Participated in some group meetings. Provided some leadership. Did some of the work assigned by the group.~~	~~Participated in most group meetings. Provided leadership when asked. Did most of the work assigned by the group~~	Participated in all group meetings, assumed leadership role as necessary. Did the work that was assigned by the group.
Communication/listening Information sharing	~~Rarely listens to, shares with, or supports the efforts of others. Is always talking and never listens to others. Provided no feedback to others. Does not relay any information to teammates~~	~~Usually listens to, shares with, and supports the efforts of others. Sometimes talks too much. Provided some effective feedback to others. Relays some basic information – most relates to the topic.~~	~~Almost always listens to, shares with, and supports the efforts of others. Seldom talks too much. Provides good feedback to others. Relays solid basic information – usually relates to the topic.~~	Always listens to, shares with, and supports the efforts of others. Provided effective feedback to other members. Relays a great deal of information – all relates to the topic.

http://www.google.com/#hl=en&q=group+work+rubric&aq=f&oq=&aqi=g4&fp=flbC24gbdiA