EDC 365E/UTS 360: Project-Based Instruction

PBI Unit Project: **Rooftop Gardening Kit**

**Benchmark Lesson 1A and Benchmark Lesson 1B**

**Overview of the lessons**

This lesson will be divided into two days in order to cover essential concepts needed for the rest of the project. The first day will cover an introduction to Mendelian genetics and vocabulary. The first portion of the lesson will be a quick power point presentation on Mendelian genetics to get students introduced to the material. Students will then “play” a game show\* that will require them to work in groups and to come up with answers to the questions. They will use a poll everywhere or a clicker system to answer the questions once each group has agreed on an answer. After each question each of the multiple choice answers will be discussed to make sure that all the students are on the same page (two-tiered.) The second day will concentrate on Punnett squares. Students will learn how to do Punnett squares, phenotypes, genotypes, and test- crosses. Students will be given a worksheet that they will be able to work on between slides so that they understand the concepts\*\*. Students will work in groups or partners so that they can help each other and discuss the subject.

**Objectives**

Students will be able to:

* Understand important vocabulary
* Apply vocabulary words to other material
* Make connections between vocabulary, examples and their target product
* Apply newly learned material to do practice problems
* Understand Punnett squares and be able to do application problems

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This lesson addresses the following TEKS:

**§112.34. Biology, Beginning with School Year 2010-2011**

(c) Knowledge and skills.

(6) Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and the principles of Mendelian Genetics. The student is expected to:

(D) Recognize that gene expression is a regulated process;

(F) Predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance;

\*Mendelian Game show on power point

\*\* Worksheet below 1A

\*\*Worksheet below 1B

\*\*\*Vocabulary sheet for equity below

**Mendelian Genetics Vocabulary Sheet**

**Allele:** The alternative forms of a gene, like the "tall" and "short" versions of the gene for height in garden peas.   
**Dominant**: An allele that produces the visible or measurable trait in an organism and is expressed over recessive genes. Dominant alleles are represented by a capital letter ("T").  
**Genotype**: The specific combination of alleles possessed by an individual. Example: "homozygous dominant," which means possessing two copies of the dominant allele.  
**Homozygous:** Possessing two copies of the same allele, both dominant or both recessive. Example: "TT" or "tt."  
**Heterozygous:** Possessing two different alleles. Example: "Tt."  
**Phenotype:** The detectable or measurable characteristic of an organism. Example: tall. The phenotype can, but doesn't always, indicate the genotype.  
**Recessive:** An allele that is expressed only when the dominant allele is not present. Recessive alleles are represented by a lowercase letter ("t").  
**Trait:** A feature or characteristic of an organism that can be tested for or observed.

**Crossing over**: Exchange of genetic material between non-sister chromatids from homologous chromosome during prophase I of meiosis; results in new allele combinations

**Genetics:** Branch of biology that studies heredity

**Heredity**: Passing on of characteristics from parents to offspring

**Hybrid:** Offspring formed by parents having different forms of a specific trait.

**Law of independent assortment:** Mendelian principal stating that genes for different traits are inherited independently of each other.

**Law of segregation**: Mendelian principal explaining that because each plant has two different alleles, it can produce two different types of gametes. During fertilization, male and female gametes randomly pair to produce four combinations of alleles.

**Test-cross:** The cross of an organism with an unknown dominant genotype with an organism that is homozygous recessive for that trait

Sources:

Genetics Vocabulary. (n.d.). Retrieved May 10, 2015, from http://www.ric.edu/faculty/ptiskus/peas/Genetics Vocabulary.htm

**Punnett Squares and Mendel Benchmark #1A**

**Let’s recall…**

**What were some of the traits that Mendel was looking at when studying pea plants? List at least 3:**

**Write “Phenotype” or “Genotype” next to the appropriate example:**

1. Hh:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Blue eyes: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. TT:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Tall:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Are these PHENOTYPES or GENOTYPES? (Circle one) For each of the following write “Ho” or “He” if it is homozygous or heterozygous:**

1. HH: \_\_\_\_\_\_\_\_\_\_\_
2. Hh: \_\_\_\_\_\_\_\_\_\_\_\_
3. LL: \_\_\_\_\_\_\_\_\_\_\_\_
4. Gg: \_\_\_\_\_\_\_\_\_\_\_\_
5. gg: \_\_\_\_\_\_\_\_\_\_\_\_\_
6. Jj: \_\_\_\_\_\_\_\_\_\_\_\_\_
7. kk: \_\_\_\_\_\_\_\_\_\_\_\_\_

**What is the first generation in a cross called? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**What about the second generation? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**How about the third?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Give an example of a crossing with the three generations you listed above. Don’t use flowers, try to be original!**

**Give an example of the following words. Think of them in terms of the same problem. For example: The phenotype of a pea plant is wrinkle, the genotype Ww, it is heterozygous. If I make the crosses from the previous problem I will get…**

**Punnett Square Practice Benchmark #1B**

Do the following monohybrid cross: Green eyes are dominant to Blue eyes (Use the letter “G” for the alleles.

**Genotype:\_\_\_\_\_\_\_\_\_\_\_**

**Phenotype:\_\_\_\_\_\_\_\_\_\_**

**How many are dominant?\_\_\_\_\_**

**How many are recessive?\_\_\_\_\_**

A heterozygous black rabbit is crossed with a homozygous white rabbit. List the parents, the phenotypes, genotypes, and do a Punnett square to show what their offspring will look like (phenotypes, genotypes and percentages)

****

Do the following P, F1 and F2 generation crosses given that the parent mouse is homozygous dominant brown and the other parent is homozygous recessive grey. List all the appropriate ratios, phenotypes, genotypes for all the generations.

**P Generation:**

**Phenotypes:**

**Genotypes:**

**Ratios:**

**F1 Generation:**

**Phenotypes:**

**Genotypes:**

**Ratios:**

**F2 Generation:**

**Phenotypes:**

**Genotypes:**

**Ratios:**

**Test- cross Practice:**

**Always cross the unknown genotype with a homozygous recessive**

1. In mink, black fur is dominant over white fur. Since the market for black mink coats is higher than white mink, you (being the entrepreneur that you are) decide to only raise black mink. Everything is going well but the guy you bought your mink from seemed a little crooked! You want to make sure they are pure breeds so you run a test-cross.
   1. Give the phenotypes of the mink in your test-cross:

\_\_\_\_\_\_\_\_\_\_\_\_X\_\_\_\_\_\_\_\_\_\_\_

* 1. In your first test-cross, 30 out of 60 offspring are black and the rest are white! No wonder you got such a good deal! What are the genotypes of the mink used in your test-cross? (Use “B” and “b”)

|  |  |
| --- | --- |
|  |  |
|  |  |

****\_\_\_\_\_\_\_\_\_\_\_X\_\_\_\_\_\_\_\_\_\_ Diagram the cross:

Genotypic ratio=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Phenotypic ratio=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. Was the black-furred mink you chose for your test-cross a pure breed? What is his genotype? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Source: biology.savithasastry.com**

**Investigation 1**

**Overview of the investigation**

“Crossing Different Types of Seeds” Students will use the knowledge acquired during the previous two day lessons “Benchmark 1A, 1B” to investigate the crossing of seed types for their garden kit and the potential bugs that may arise. Students will try to figure out a combination/ cross that gives them the best seeds. They will be free to do as many crosses as they want just as long as they can justify why the particular seed they obtain is the best. The same thing will apply for the “Crossing Bugs” Part 2 of the Investigation 1. The students will be given a number of bugs that have specific traits. They will be free to cross whichever bugs they want just as long as they can justify why they chose that specific cross and progeny. Overall students should be able to use Punnett Squares and Mendelian Genetics to come up with the best kinds of seeds they can put in their kits and the least harmful (best bugs) bugs that can be around their rooftop gardens. Both of these criteria are to be included in their final artifact. First, Second and Third levels of inquiry will apply to this investigation. Students will use the previous day’s worksheets that should have shown “Confirmation” that they understood the concepts to work on the day’s activities. I will give another example as a bell ringer to recap the Benchmark lesson and make sure the students are on the same page. The bell ringer will be a guided question where I provide the students all the information they need but where they themselves have to provide an explanation. Finally the main portion of the lesson is centered on level 3 inquiry where students will choose what to cross and will have to justify why they settled with that specific cross.

**Objectives**

Students will be able to:

* Make predictions about phenotypes when given a genotype through Punnett squares
* Analyze how different genotypes affect phenotypic outcomes
* Conduct an investigation using “strains” to obtain the genotypic and phenotypic outcomes.
* Justify and explain the outcomes of their investigation.

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This investigation addresses the following TEKS:

**§112.34. Biology, Beginning with School Year 2010-2011**

c) Knowledge and skills.

(2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:

(G) Analyze, evaluate, make inferences, and predict trends from data;

(6) Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and the principles of Mendelian Genetics. The student is expected to:

(A) … Describe how information for specifying the traits of an organism is carried in the DNA;

(D) Recognize that gene expression is a regulated process;

(F) Predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance;

\*Formative Assessment: Bell Ringer

**Bell Ringer**

**Answer the following question to the best of your ability. Show your work:**

1. What are the possible offspring of the following crossing:

Homozygous rose without thorns (tt) *×* Heterozygous rose with thorns (Tt)?

1. Yellow seeds are dominant over green seeds in pea plants. Fill in the Punnett square and determine the expected genotypic and phenotypic ratios from crossing homozygous recessive and homozygous dominant parents.

Genotype:

Phenotype:



**Investigation 1A: Crossing Seeds**

You will be choosing the seeds that you will put in your kit. Think about the possible crosses you can make with the following genotypic (make them heterozygous if you’d like.) Do all the Punnett square combinations necessary to get at least 3 types of seeds to put in your kit. List phenotypes, genotypes and the percentage of that specific genotype you can get from your cross. Why are each of the seeds chosen good?

**Genotypic alleles to choose from:**

**T= tall**

**t= short**

**G= dark green and lots of photosynthesis**

**g= light green not a lot of photosynthesis but doesn’t require much light**

**L= leafy**

**l= barren**

**F= fruit producing and can attract bugs**

**f= no fruits no bugs**

**W= flowers attracts bees**

**w= no flower**

**H= lots of water needed but produces fruit**

**h= little water needed but does not produce fruit**

**S= Requires sun**

**s= Dies under the sun**

**Investigation 1B: Crossing Bugs**

You will be looking at the possible bugs that may affect your garden. Think about the possible crosses you can make with the following genotypic alleles (make them heterozygous if you’d like.) Do all the Punnett square combinations necessary to get at least 3 types of bugs that you should warn your costumers about when they are buying your kit (Got to keep it honest!) List phenotypes, genotypes and the percentage of that specific genotype you can get from your cross. Why are each of the bugs good or bad?

**B= African queen bee (can cause serious health hazards but hard workers)**

**b= African worker bee (can cause less serious health hazards, hard workers)**

**Y= normal bees**

**y- bees missing one wing**

**R= red eyed mosquitos (buzzers)**

**r= green eyed mosquitos (lots of babies)**

**M= Mexican long wing bats (eat fruit, lots of them)**

**m- Mexican short wing bats (less food required, less work, lots of them)**

**Benchmark Lesson 2**

**Overview of the lesson**

This lesson will give students the opportunity to do a lot of practice problems and look at different scenarios to which the concepts regarding dominance and dihybrid crosses can apply. The main idea of this lesson is to discuss how there are more than 2 traits that can influence an outcome. The understanding of this concept will be useful for students to perform the second investigation regarding flowers and their kits. The instructor will give a presentation on dihybrid crosses, co- dominance and dominance. For each of the three sections students will be given the opportunity to get into groups and work on “real- life” situations to where these concepts may apply. Students will be asked to share the answers to the problems with each group being responsible for one specific problem and for being the “teachers” when explaining them to their peers.

**Objectives**

Students will be able to:

* Verbally communicate scientific concepts
* Perform test- crosses, dihybrid and monohybrid crosses
* Predict genotypes and phenotypes
* Apply and transfer knowledge from one setting to another

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This lesson addresses the following TEKS:

**§112.34. Biology, Beginning with School Year 2010-2011**

(c) Knowledge and skills.

(2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:

(G) Analyze, evaluate, make inferences, and predict trends from data; and

(H) Communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

(6) Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and the principles of Mendelian Genetics. The student is expected to:

(A) Identify components of DNA, and describe how information for specifying the traits of an organism is carried in the DNA;

(D) Recognize that gene expression is a regulated process;

(F) Predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance;

**Class Problems:**

1. Explain the difference between incomplete dominance and codominance:

2. In some chickens, the gene for feather color is controlled by codiminance. The allele for black is B and the allele for white is W. The heterozygous phenotype is known as erminette.

a. What is the genotype for black chickens? \_\_\_\_

b. What is the genotype for white chickens? \_\_\_\_

c. What is the genotype for erminette chickens? \_\_\_\_

3. Mom has type A blood. Dad has AB type. List all the possible types of blood their kids could have. Show your work by drawing the Punnett squares.

**Dihybrid Crosses:**

Worksheet available at: http://www.cbhs.k12.nf.ca/stephenwhalen/dihybridcross.pdf

**Source:**

Whalen, S. (n.d.). Dihybrid Cross Worksheet. Retrieved May 10, 2015, from

http://www.cbhs.k12.nf.ca/stephenwhalen/dihybridcross.pdf

**Incomplete and Codominance:**

Worksheet available at:

<http://atlncs.org/hardon/files/2015/02/incomplete-and-codominance.pdf>

**Source:**

Hardon. (n.d.). Incomplete and Codominance Worksheet. Retrieved May 10, 2015, from http://atlncs.org/hardon/files/2015/02/incomplete-and-codominance.pdf

**Investigation 2**

**Overview of the investigation**

Students will be shown that there are other non- Mendelian factors influencing genetics. Applications on co- dominance and incomplete dominance will be done following a bell ringer where students should get together with their groups and think of traits that could be labeled co- dominant or incomplete dominance. Each group will need to explain why they chose the trait and whether or not they think the trait could be expressed in different organisms. Students will then proceed to engage in inquiry by looking at potential flowers they would like their rooftop gardens to have. Students will pursue level inquiry 3 where they will need to come up with the traits that they want in their flowers and the types of crosses they would need to make to obtain them. Additionally students should come up with a flower that shows co- dominance and one that shows incomplete dominance. While finding the crosses and types they want they will need to keep in mid the math concepts such as price and overall cost.

**Objectives**

Students will be able to:

* Make predictions about phenotypes when given a genotype through Punnett squares
* Analyze how different genotypes affect phenotypic outcomes
* Conduct an investigation using “strains” to obtain the genotypic and phenotypic outcomes.
* Justify and explain the outcomes of their investigation.

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This investigation addresses the following TEKS:

**§112.34. Biology, Beginning with School Year 2010-2011**

c) Knowledge and skills.

(2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:

(G) Analyze, evaluate, make inferences, and predict trends from data;

(6) Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and the principles of Mendelian Genetics. The student is expected to:

(A) … Describe how information for specifying the traits of an organism is carried in the DNA;

(D) Recognize that gene expression is a regulated process;

(F) Predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance;

**Investigation 2: Crossing Flowers**

You will be choosing the types of flowers that you will put in your kit. Think about the possible crosses you can make with the following genotypic. You will be doing dihybrid crosses to get multiple alleles in the genotype. Do all the Punnett square combinations necessary to get at least 2 types of flowers to put in your kit. Show a flower that shows codominance, incomplete dominance and/or other dihybrid cross. List phenotypes, genotypes and the phenotypic and genotypic ratios you can get from your cross. Cross the Parent generation and from that the F1 and from that make your dihybrid cross. Why are these good/ bad flowers to have in your kit?

**Pink and sweet= PpSS**

**Blue and tart= PPSs**

**Leafy purple= LlPp**

**Leafy white= LLpp**

**Red tall= RrTT**

**Red dwarf= rrtt**

**White tall= ppTT**

**White dwarf= pptt**

**Benchmark Lesson 3**

**Overview of the lesson**

This lesson will be showing students how to graph linear functions and what domain and range mean. Students will learn by exploring how linear graphs work by looking at data tables and seeing the relationships between them. Students will already have seen linear functions, so students will work individually first and then pair up to check answers with a partner. Their exit ticket for that day is to have activity checked off by teacher. The second day of the lesson students will work in groups to create their own data table and put it into a graph. They also will need to identify the domain and range. Then students must predict from looking at the graph what data points that are not represented in their table will be and justify. Once everyone has finished the teacher finds a group that had a mistake in it and asks them to present their work to see if the class can find their error. If no one made any mistakes, then have groups present and explain how they did their activity. This type of interaction allows for the teacher to scaffold the students in their learning, and for them to be able to learn from their peers instead of only hearing from the teacher.

**Objectives**

Students will be able to:

1. Determine functional relationships from data

2. Make predictions about collected data from functional relationships

3. Represent data in a graph

4. Identify domains and ranges of functions

5. Explain their reasoning written down and verbally.

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This lesson addresses the following TEKS:

Algebra 1

(b) Knowledge and skills.

(1) Foundations for functions. The student understands that a function represents a dependence of one quantity on another and can be described in a variety of ways. The student is expected to:

(A) Describe independent and dependent quantities in functional relationships;

(B) Gather and record data and use data sets to determine functional relationships between quantities;

(D) Represent relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities; and

(E) Interpret and make decisions, predictions, and critical judgments from functional relationship

(2) Foundations for functions. The student uses the properties and attributes of functions. The student is expected to:

(A) Identify and sketch the general forms of linear (y = x) and quadratic (y = x2) parent functions; (B) Identify mathematical domains and ranges and determine reasonable domain and range values for given situations, both continuous and discrete;

(C) Interpret situations in terms of given graphs or creates situations that fit given graphs; and

(D) Collect and organize data, make and interpret scatterplots (including recognizing positive, negative, or no correlation for data approximating linear situations), and model, predict, and make decisions and critical judgments in problem situations

(6) Linear functions. The student understands the meaning of the slope and intercepts of the graphs of linear functions and zeros of linear functions and interprets and describes the effects of changes in parameters of linear functions in real-world and mathematical situations. The student is expected to:

(A) Develop the concept of slope as rate of change and determine slopes from graphs, tables, and algebraic representations;

(B) Interpret the meaning of slope and intercepts in situations using data, symbolic representations, or graphs;

\*Worksheets next page

**Worksheets**

**First day worksheet**

José measured the amount of gas his car used when he drove it for various distances.

He arranged his data in the table below.

|  |  |
| --- | --- |
| Miles Driven (x) | Gallons of Gas Used (y) |
| 20 | 1 |
| 40 | 2 |
| 50 | 2.5 |
| 60 | 3 |
| 70 | 3.5 |

Is this data a function? Why or why not?

What is the slope the line for this data?

What are the independent and dependent variables?

Independent:

Dependent:

What equation represents the data above?

Can all of the ordered pairs in the table be generated using the equation?

Does the equation y= 21- x represent the relationship shown in the table above? Why or why not?

If the values in the second column in the table were all twice their current value, what equation would express the relationship between x and y?

**Source:**

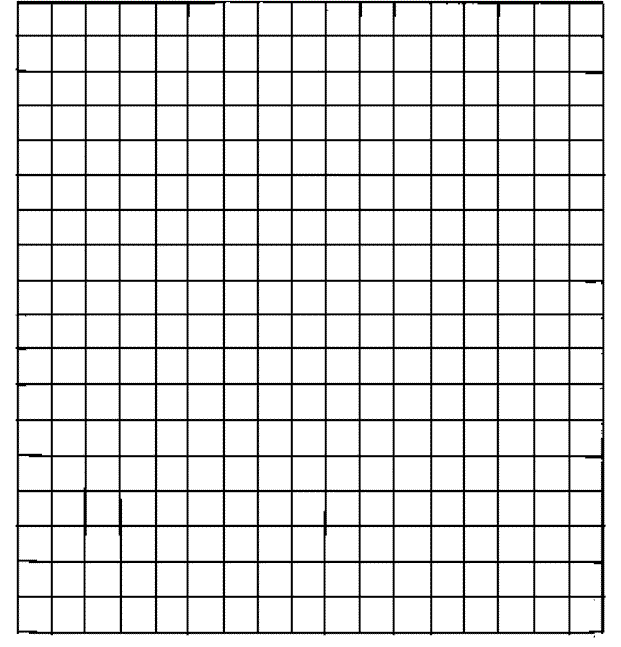
[**http://nimitz9livingston.pbworks.com/f/Obj+1+Lesson+2+Wkbk.pdf**](http://nimitz9livingston.pbworks.com/f/Obj+1+Lesson+2+Wkbk.pdf)

**Second day worksheet**

You and your partner must create your own data table, and then put it into a graph. You must have a linear graph, and write out what your equation is.

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Graph



Domain:

Range:

Is your graph a function, why or why not?

Make a prediction about a data point that is not represented on your data table from looking at your graph. Explain how you got that value.

**Investigation 3**

**Overview of the investigation**

Students will be looking at plant growth data tables and graphing linear functions from them. From their linear graphs that they make they will be able to make predictions about the best fertilizer for plants to grow in. This will be level 3 inquiry in that the students will be given a question by the teacher but have formulate their own procedure and analysis. The goal of having the students do this is to apply graphing linear equations and be able to use them to predict future outcome from data. This is also a step they need to take to produce their final artifact. They will be working in groups of 2 and researching online plant growth data for different fertilizers. Then we will combine as a class once everyone has picked what fertilizer they think is best.

Students will be able to:

1. Determine functional relationships from data

2. Make and analyze predictions about collected data from functional relationships

3. Represent data in a graph

4. Identify domains and ranges of functions

5. Research data online

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This investigation addresses the following TEKS:

(1) Foundations for functions. The student understands that a function represents a dependence of one quantity on another and can be described in a variety of ways. The student is expected to:

(A) Describe independent and dependent quantities in functional relationships;

(B) Gather and record data and use data sets to determine functional relationships between quantities;

(D) Represent relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities; and

(E) Interpret and make decisions, predictions, and critical judgments from functional relationship

(2) Foundations for functions. The student uses the properties and attributes of functions. The student is expected to:

(A) Identify and sketch the general forms of linear (y = x) and quadratic (y = x2) parent functions; (B) Identify mathematical domains and ranges and determine reasonable domain and range values for given situations, both continuous and discrete;

(C) Interpret situations in terms of given graphs or creates situations that fit given graphs; and

(D) Collect and organize data, make and interpret scatterplots (including recognizing positive, negative, or no correlation for data approximating linear situations), and model, predict, and make decisions and critical judgments in problem situations

(5) Linear functions. The student understands that linear functions can be represented in different ways and translates among their various representations. The student is expected to:

(A) Determine whether or not given situations can be represented by linear functions;

(B) Determine the domain and range for linear functions in given situations; and

(C) Use, translate, and make connections among algebraic, tabular, graphical, or verbal descriptions of linear functions.

\*Worksheets below

**Math Investigation 1:**

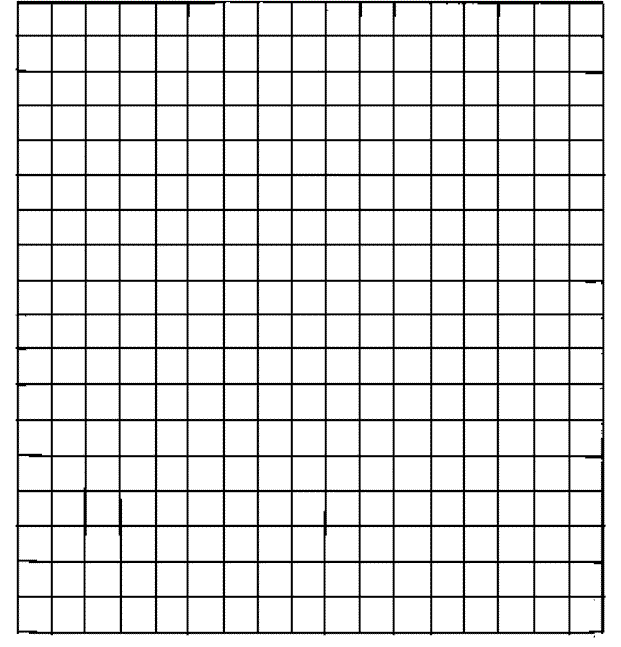
**Example data table**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Fertilizer** | **Day 1** | **Day 3** | **Day 5** | **Day 7** | **Day 9** | **Day 11** | **Day 13** | **Day 15** |
| **1** | **5cm** | **7cm** | **9cm** | **11cm** | **13cm** | **15cm** | **17cm** | **19cm** |
| **2** | **3cm** | **6cm** | **7cm** | **9cm** | **12cm** | **14cm** | **15cm** | **17cm** |
| **3** | **0cm** | **1cm** | **5cm** | **6cm** | **8cm** | **11cm** | **15cm** | **18cm** |
| **4** | **1cm** | **2cm** | **4cm** | **8cm** | **9cm** | **15cm** | **20cm** | **24cm** |

Your groups goal is to find research on different types of fertilizers (at least 4) and their plant growth (as in the example above), and then formulate a linear equation from the data you collect. Then from that linear data you collect you must make a prediction as to what the best fertilizer is for plant growth.

Data table:

Graph:



Which fertilizer is best and why?

**Investigation 4**

**Overview of the lesson**

The goal of this lesson is for students to find out what is not only the best fertilizer for growth, but which one is the most cost efficient as well. This will be level 3 inquiry, because we will give them the problem and they have to come up with how to solve it and analyze it. The students will look back at the data that they collected in previous investigation. They will then have to research the cost of each type of fertilizer, and put those in table alongside the data table they created in the prior investigation. In their groups they will make a linear graph representing the costs and analyze which fertilizer is best based on price and plant growth. We will then come together as class and talk about should we pay more for better product, or will the cheaper stuff do just as good. This gets students to justify why they make certain choices.

**Objectives**

Students will be able to:

1. Graph linear data and interpret it.
2. Understand mathematical terms and their applications in science.
3. Verbally describe linear functions through their experimental findings.

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This lesson addresses the following TEKS:

(1)(E) Interpret and make decisions, predictions, and critical judgments from functional relationships.

(2)(C) Interpret situations in terms of given graphs or creates situations that fit given graphs; and

(D) Collect and organize data, make and interpret scatterplots (including recognizing positive, negative, or no correlation for data approximating linear situations), and model, predict, and make decisions and critical judgments in problem situations.

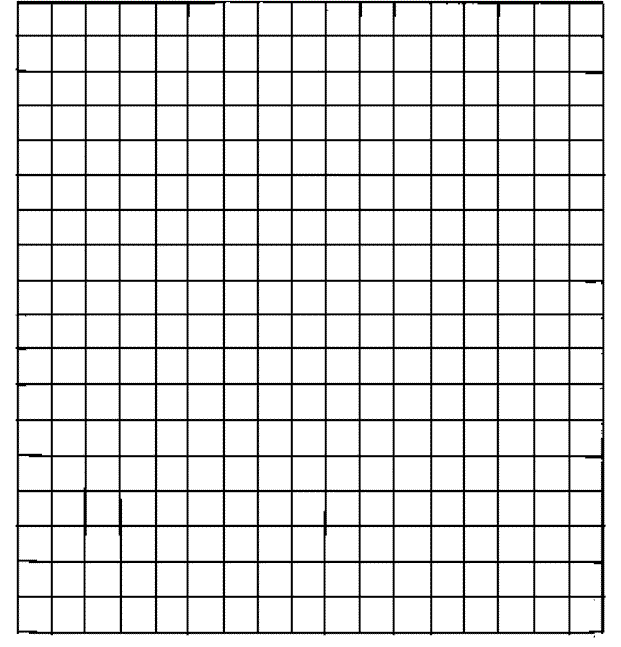
**\*Worksheet below**

**Investigation 4**

Looking back at the data we collected on plant growth, for those same fertilizers look up prices per lb. for each fertilizer and make a table. Graph this table, and compare the plant growth data you collected to the price.

Data table:

Graph:



From looking at both price and growth rates, which fertilizer would you choose and why?

**Benchmark Lesson 4**

**Overview of the lesson**

This lesson is over how to interpret slope, and how to use slope to help us predict costs. The students will have just completed an investigation on this topic. They will be given a worksheet to complete individually first, and then combine into groups to correct work, or brainstorm ideas on how to complete the problem. Then the class will come back together as a whole and a group will present their work while the rest of the class makes sure it was done correctly. The teacher’s role in this is to monitor students’ progress as they work on the activity and present.

**Objectives**

Students will be able to:

1. Predict data from the slope of graphs
2. Explain which variable is more cost efficient from linear graphs.

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This lesson addresses the following TEKS:

(6) Linear functions. The student understands the meaning of the slope and intercepts of the graphs of linear functions and zeros of linear functions and interprets and describes the effects of changes in parameters of linear functions in real-world and mathematical situations. The student is expected to:

(A) Develop the concept of slope as rate of change and determine slopes from graphs, tables, and algebraic representations;

(B) Interpret the meaning of slope and intercepts in situations using data, symbolic representations, or graphs;

(C) Investigate, describe, and predict the effects of changes in m and b on the graph of y = mx + b;

(D) Graph and write equations of lines given characteristics such as two points, a point and a slope, or a slope and y-intercept;

(E) Determine the intercepts of the graphs of linear functions and zeros of linear functions from graphs, tables, and algebraic representations;   (F) Interpret and predict the effects of changing slope and y-intercept in applied situations; and

(G) Relate direct variation to linear functions and solve problems involving proportional change.

**Worksheet:**

Source:

<https://app.activateinstruction.org/resource/view/id/52fa5bf407121c1a2f37bacd/bc0/user/bc0_id/52e2e8c907121cdf71eb7a30>

Building functions represented in different ways | Activate Instruction. (n.d.). Retrieved May 8, 2015, from https://app.activateinstruction.org/resource/view/id/52fa5bf407121c1a2f37bacd/bc0/user/bc0\_id/52e2e8c907121cdf71eb7a30

**Benchmark Lesson 5**

**Overview of the lesson**

The instructor will cover a short lecture on the key ideas behind H-W including the formulas and “rules” that should be kept in mind. The instructor will ask the students to get into groups in order to do practice problems that are interactive. Students will use the information given during the short lecture to answer the problems on Pearson’s Lab Bench website. Once students have completed the problems the instructor will poll their answers and ask the students to again play “teachers” and explain their answer to their peers. The instructor will then ask students to research a population of plants that they would like to look at in terms of growth. The latter should prepare them for the investigation that will occur the next day.

**http://www.phschool.com/science/biology\_place/labbench/lab8/hardwein.html**

**Objectives**

Students will be able to:

* Make predictions about populations using the Hardy- Weinberg equation and draw plots
* Understand the limitations of Hardy- Weinberg including but not limited to the “Five Rules”
* Make predictions about phenotypes when given a genotype through Punnett squares
* Analyze how different genotypes affect phenotypic outcomes

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This lesson addresses the following TEKS:

**§112.34. Biology, Beginning with School Year 2010-2011**

(c) Knowledge and skills.

(2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:

(G) Analyze, evaluate, make inferences, and predict trends from data; and

(6) Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and the principles of Mendelian Genetics. The student is expected to:

(A) Identify components of DNA, and describe how information for specifying the traits of an organism is carried in the DNA;

(D) Recognize that gene expression is a regulated process;

(F) Predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance;

(7) Science concepts. The student knows evolutionary theory is a scientific explanation for the unity and diversity of life. The student is expected to:

(C) Analyze and evaluate how natural selection produces change in populations, not individuals;

(D) Analyze and evaluate how the elements of natural selection, including inherited variation, the potential of a population to produce more offspring than can survive, and a finite supply of environmental resources, result in differential reproductive success;

**§111.32. Algebra I (One Credit).**

(b) Knowledge and skills.

(9) Quadratic and other nonlinear functions. The student understands that the graphs of quadratic functions are affected by the parameters of the function and can interpret and describe the effects of changes in the parameters of quadratic functions. The student is expected to:

(D) Analyze graphs of quadratic functions and draw conclusions.

**Investigation 5**

**Overview of the investigation**

Students will use population genetics and the information learned during the previous Benchmark lessons specifically Benchmark Lesson 5 in order to apply their understanding of Hardy-Weinberg theorem. Students will look up and analyze data of a population of plants that are living versus one that is dying. Based on the data, the plants traits and their understanding of Hardy- Weinberg rules students should come up with ways in which this data could fit the Hardy- Weinberg theorem. Students will be performing inquiry because they will be required to record and plot the data along with figuring out the p and q values that are needed to obtain Hardy Weinberg equilibrium. The level of inquiry will be structured since we will be giving students guiding information in order for them to successfully complete the task. Overall students will be looking at plant populations that may be present in the rooftop area of interest. The application of H-W to the data they find will be discussed and shared together as a class. An exit ticket will be given to students that tests their understanding of Hardy-Weinberg in another scenario that does not pertain to plants i.e., blood typing.

**Objectives**

Students will be able to:

* Make predictions about populations using the Hardy-Weinberg equation and draw plots
* Make predictions about phenotypes when given a genotype through Punnett squares
* Analyze how different genotypes affect phenotypic outcomes

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This investigation addresses the following TEKS:

**§112.34. Biology, Beginning with School Year 2010-2011**

(c) Knowledge and skills.

(2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:

(G) Analyze, evaluate, make inferences, and predict trends from data; and

(6) Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and the principles of Mendelian Genetics. The student is expected to:

(A) Identify components of DNA, and describe how information for specifying the traits of an organism is carried in the DNA;

(D) Recognize that gene expression is a regulated process;

(F) Predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance;

(7) Science concepts. The student knows evolutionary theory is a scientific explanation for the unity and diversity of life. The student is expected to:

(C) Analyze and evaluate how natural selection produces change in populations, not individuals;

(D) Analyze and evaluate how the elements of natural selection, including inherited variation, the potential of a population to produce more offspring than can survive, and a finite supply of environmental resources, result in differential reproductive success;

**§111.32. Algebra I (One Credit).**

(b) Knowledge and skills.

(9) Quadratic and other nonlinear functions. The student understands that the graphs of quadratic functions are affected by the parameters of the function and can interpret and describe the effects of changes in the parameters of quadratic functions. The student is expected to:

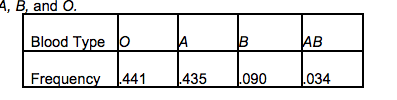
(D) Analyze graphs of quadratic functions and draw conclusions.

**Exit Ticket**

List at two of the assumptions required for H-W theorem:

1.

2.

A study of the blood types in France produced information in the table below. What fraction of type A individuals are AO heterozygotes? Determine the frequencies of the alleles A, B, and O.

**Data Source:** http://www19.homepage.villanova.edu/alice.deanin/courses/Mat7310/Hardy% 20Weinberg.htm)

**Practice Problem:**

**If 95 out of 200 plants in a population express the recessive phenotype, what percent of the population would you predict would be heterozygotes?**

(a) I have given you information on the frequency of the homozygous recessive (or q2). So start by determining q2 and then solving for q.

(b) Now that you have q, you can solve for p. Remember there are only two alleles in the population, so if you add the frequency of the two alleles, you have accounted for all possibilities and it must equal 1. So p + q = 1.

(c) Now what is the formula for heterozygotes? Think back to the Hardy-Weinberg equation -- it is dealing with the genotypes of individuals in the population.

(d) Now that you have figured out the % of heterozygotes, can you figure out the % of homozygous dominant? Does the % of homozygous dominant, heterozygotes and homozygous recessive individuals add up to 100%? If not, you have made an error. Those are the only three genotypes possible with only two alleles and a simple dominant and recessive relationship.

Adapted from: Indiana. edu

**Benchmark Lesson 6**

**Overview of the lesson**

This lesson will be over quadratic equations, and how to interpret their graphs. This will be done through 5E type lesson. We will look as a class at what is a quadratic function, and then in groups the students will be given an activity that looks into what are similarities and differences between a linear and quadratic graph, and be able to describe why quadratic functions are shaped the way they are. After completing this the teacher will ask a couple groups to share their activity, and scaffold student discussion.

**Objectives**

Students will be able to:

1. Identify what a quadratic function looks like.
2. Analyze graphs of quadratic functions.

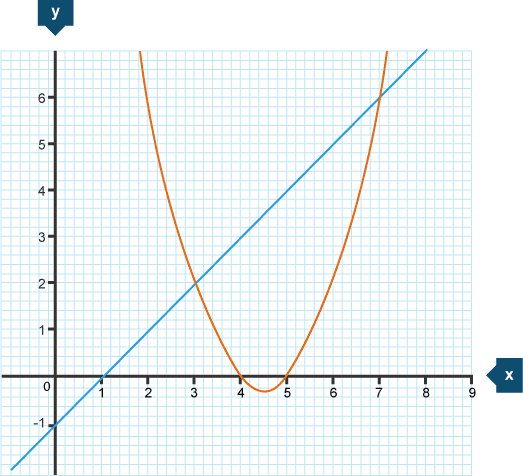
**Alignment with Texas Essential Knowledge and Skills (TEKS)**

This lesson addresses the following TEKS:

(9) Quadratic and other nonlinear functions. The student understands that the graphs of quadratic functions are affected by the parameters of the function and can interpret and describe the effects of changes in the parameters of quadratic functions. The student is expected to:

(D) Analyze graphs of quadratic functions and draw conclusions.

**Benchmark 6: Quadratics**

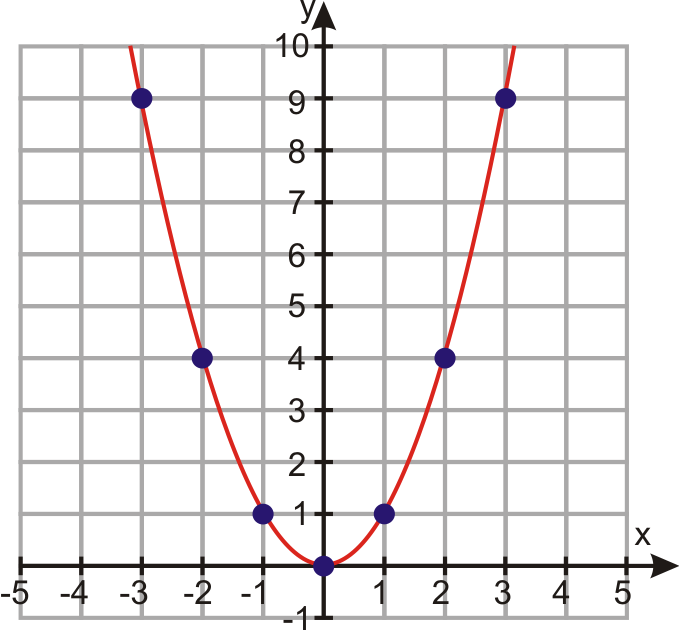


http://www.bbc.co.uk/schools/gcsebitesize/maths/algebra/quadequationshirev4.shtml

What is similar and different from these two graphs?

Similarities:

Differences:



http://www.ck12.org/algebra/Quadratic-Functions-and-Their-Graphs/lesson/Quadratic-Functions-and-Their-Graphs-Intermediate/

Why is this graph not considered a linear graph?

Make a word problem that describes this graph.

**Investigation 6**

**Overview of lesson:**

This lesson will be about how Hardy-Weinberg applies to us. It will be an inquiry level 3 assignment because students will be looking into our population growth in groups to see when our food consumption will exceed our food production. The students must come up with the data to support their claim, and analyze the graphs. After they have completed the activity the teacher will lead a group discussion over the activity, asking students to present their findings and getting other students to participate in discussion.

**Objectives:**

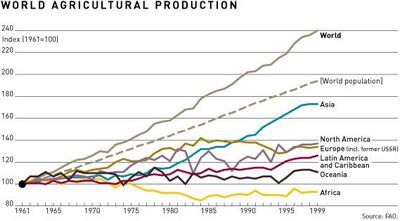
1. Analyze graphs of linear and quadratic functions.

**Alignment with Texas Essential Knowledge and Skills (TEKS)**

**(**9) Quadratic and other nonlinear functions. The student understands that the graphs of quadratic functions are affected by the parameters of the function and can interpret and describe the effects of changes in the parameters of quadratic functions. The student is expected to:

(D) Analyze graphs of quadratic functions and draw conclusions.

**Investigation: Quadratics**



**http://growthmadness.org/2007/12/06/russell-hopfenberg-on-food-supply-carrying-capacity-and-population-follow-up-responses-to-readers-comments/**

Here is an example of the world’s food production, and world population growth. The goal for you today is to be able look at how fast our world is growing and how fast our food production is growing and decide when or if we will have a shortage of food production on Earth.

Sketch the graphs/tables and write down your reasoning.

Graphs/Tables

Explanation: