HAWAI'I'S KALO AND CULTURE

Included in this chapter:

◊ Kalo Activity Sheet #1 and #2

Written by Marissa Kobayashi

Part 1: Introduction and History

Taro, or kalo, is one of the oldest cultivated crops in the world. Mentioned in Chinese writings as early as 100 B.C., kalo was believed to have originated in India or Southern Asia (Krauss, 1993). Kalo reached Egypt and the Mediterranean parts of Europe about 2,000 years ago, where it subsequently spread throughout the Pacific Area (Nonnecke, 1989). According to Kirch (1985), the Polynesians arrived in Hawai'i around 1100 A.D. bringing with them an array of foods, including kalo. The kanaka maoli, the indigenous Hawaiian people, consumed kalo on a daily basis where each person was thought to eat approximately 5-15 lbs. of poi (Ebel & Mak, 1974). Beyond a dietary staple, kalo played a much greater role extending into the spiritual center of Hawaiian culture.

According to Hawaiian mythology, Wākea and Ho'ohokukalani, the first couple in the creation chant, gave birth to Hāloa-naka, a stillborn child (Krauss, 1993). Wākea buried his lifeless child near the house. Shortly thereafter, the kalo plant sprouted out of his body. The first couple's second son was named Hāloa after their first-born. Through Hāloa, the human race and Hawaiian people descended. Hāloa was to respect and look after (mālama) his older brother or the kalo for all eternity. Reciprocating, the first born son would sustain and nourish his younger brother and his posterity. Having descended from the second son, many native Hawaiians viewed kalo as being genealogically superior to themselves (Krauss, 1993). The value of kalo was elevated and perpetuated through this creation myth as evidenced in their language, traditions, rituals, customs, and technology.

For example, the Hawaiian terminology for family, 'ohana, is derived from a part of the kalo called 'ohā. 'Ohā is referred to as the corm or the underground stem of the plant (Krauss, 1993). Other parts of the kalo plant were used in the process of dying kapa cloth and lauhala. The leaf-stem juice and and the mud from the taro patch were used to make red and black dye, respectively. In addition, selected varieties of kalo were used as

offerings to the gods. The 300 different varieties of taro also revealed the social stratification system of Hawai'i. Producing a pinkish and purplish poi, the royal taros were exclusively reserved for the high chiefs and royalty whereas the gray and white taros were allotted for commoners. Other varieties of taro were used for medicinal purposes in healing and as offerings to the gods. Over the several centuries following the initial arrival of Polynesians, there began a progressive expansion of taro production in accordance with the expanding Hawaiian population. Around 1650 A.D., the Hawaiian population expanded over 400,000 people and was sustained through an impressive level of engineering innovations (Cho, Yamakawa, & Hollyer, 2007).

Ancient Hawai'i was widely recognized as the zenith in technological sophistication with respect to the cultivation of taro around the world. Donald D. Kiolani (1982) Mitchell, an author of Hawaiian history and culture, referred to the ancient Hawaiians as "the most sophisticated horticulturalists" (as cited in Kanahele, 1986, p. 301). With the two types of taro cultivation - dry land and wetland, the native Hawaiians favored the latter as it was 10 to 15 times more productive than dry unirrigated taro gardens (Kelly, 1989). The complex terraced pond fields (*lo'i*) and intricate irrigation system (*'auwai*) proved to be an efficient means of producing wetland taro and an undeniable feat of engineering, ingenuity, and skill (Cho et al., 2007). As an act of reverence to the kalo plant, only men could plant, harvest, and mash poi; however, the women would also mash poi when the men were not present (Krauss, 1993).

The stone-faced terraced ponds were irrigated by water from streams in the valleys or springs below the surface, which allowed extensive areas of the valleys to be cultivated. Mastering the rate or flow of water dispersed throughout the different terraces, the native Hawaiians were able to find the angles of elevation that would prevent the taro corms from rotting. Without proper circulation, the water would stagnate and overheat causing rot, but at the same time an overly intense flow of water would erode the ditches and terraces (Kelly, 1989). As recent as 2009, scientific research has found that early Hawaiian agriculture may have been more complex and extensive than previously thought (Nature). Utilizing Geographical Information Systems (GIS) mapping and previous archaeological evidence, scientists have found empirical proof of how extensive the taro and farming lands were in ancient Hawai'i, which would account for the ancient Hawaiians ability to support a population of approximately 1 million people (Kirch & Rallu, 2007).
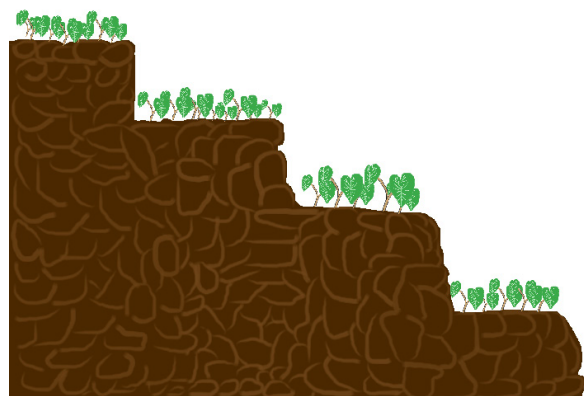
After the arrival of Captain Cook, taro cultivation began to decline because of a variety of subsequent causes and events: decrease in Hawaiian population, loss of agricultural knowledge, alternative foods from other countries, the Great Mahele of 1848, shift to cultivating rice, and change in legal rights that diverted water elsewhere (Cho et al., 2007). Challenges to cultivating taro in modern times was further complicated with the biotech industry, which seeks to genetically modify taro in order to create a more disease-resistant version. The spiritual connection and cultural beliefs had many demonstrators, activists, and protestors supporting legislation that places a moratorium on the genetic modification of their revered kalo plant(Niesse, 2007).

Part II: Goals of Lesson Plan

1. Objective: Identify the cultural importance of kalo in Hawaiian history.

2. Objective: Explain the Creation Myth and tie the concepts of 'Ohana and Hāloa back to kalo.

3. Objective: Explain how language, traditions, rituals, customs, and technology are elements of culture.

4. Objective: Bring awareness to the contentious issue of kalo cultivation and experimentation utilizing GMO technology.

5. Objective: Plan a field study to one of the taro farms or botanical gardens.

6. Objective: Meet Common Core State Standards for Mathematics in Lesson Plans.
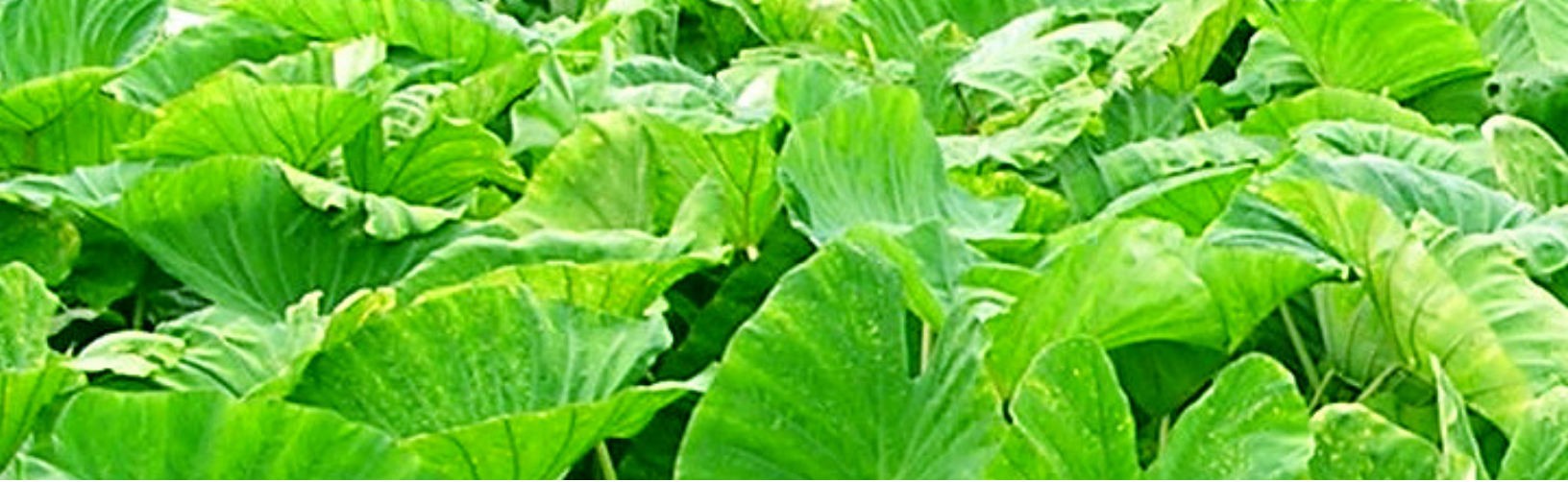
COMMON CORE STANDARDS:

8.F Define, evaluate, and compare functions.

1. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

2. Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

3. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

G-MG Apply geometric concepts in modeling situations

1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

2. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

F-LE.1. Construct and compare linear, quadratic, and exponential models and solve problems

1. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

2. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

Part III: Methodology

After providing background information and history on kalo, the instructor should define increasing, decreasing, and constant functions prior to distributing Worksheet # 1:

A function increases on an interval of its domain if its graph rises from left to right on the interval. It decreases on an interval of its domain if its graph falls from left to right on the interval. It is constant on an interval of its domain if its graph is horizontal on the interval (Lial, Hornsby, & Schneider, 2009).

◊ **Increasing**: function f <u>increases</u> over the interval if, whenever x1 < x2, then $f(x1) < f(x2)$

◊ **Decreasing**: function f <u>decreases</u> over the interval if, whenever x1 < x2, $f(x1) > f(x2)$

◊ **Constant**: function f is constant on the interval if, for every x1 < x2, then $f(x1) = f(x2)$.

The instructor should give a brief recapitulation of the history of kalo as it pertains to Worksheet #1. Worksheet #2 should be distributed.

In Worksheet #2, the instructor may choose to review slope, circular trigonometric functions, proper interval notation, and geometric area formulas prior to distribution:

Slope- Geometrically speaking, the slope of a line is a numerical measure of the steepness and can be interpreted as rise over run (Lial, Hornsby, & Schneider, 2009).

$$m = \text{rise/run}$$

Trigonometric Functions

Law of Sines - with any triangle, the ratio of a side length to the sine of its opposite angle is the same for all three sides of a triangle.

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

* In order to use the Law of Sines, there must be at least one angle and the side opposite that angle.

Proper Interval Notation - When using interval notation, there are specific ways to express the different types of intervals. An open interval is indicated through parentheses. For example, the interval (-2, 8) is an open interval with the end points, -2 and 8,

which are *NOT* part of the interval. The closed interval is indicated using square brackets. The interval [-2, 8] is a closed interval with the end points, -2 and 8, which *ARE* part of the interval (Lial, Hornsby, & Schneider, 2009).

Geometric Area Formulas - The area of a rectangle is defined as length times width. The sum of all angles in a triangle are 180 degrees.

After completion of the worksheets, the instructor can also organize a field study to one of the kalo farms or botanical gardens on Oʻahu (Kupunakalo):

1. Ka Papa Loʻi O Kānewai Native Hawaiian Cultural Gardens, UH Mānoa: 2540 Maile Way, Spalding 454, Honolulu, HI 96822

2. Lyon Arboretum in Mānoa Valley: 3680 Mānoa Road, Honolulu, HI 96822

3. Waimea Valley Botanical Collection: 59-864 Kamehameha Hwy., Haleʻiwa, HI 96712

4. Waimānalo Research Station, College of Tropical Agriculture and Human Resources: 41-698 Ahiki Street, Waimānalo, HI, 96795

5. Waianae Kaʻala Farms, Inc.: PO Box 630 Waianae, HI 96792

6. Hui Kū Maoli ola, Oʻahu - Haʻikū Area: 46-403 Haʻikū Road Kāneʻohe, Hawaiʻi 96744

* The Kupunakalo.com website features potential locations for those living on neighbor islands.

Part IV: Conclusion

The lesson plan should conclude with a group reflection that will engage students in discussion. The instructor can ask questions that highlight the significance of the kalo plant in Hawaiian history and culture. Encouraging students to share what they learned during the lesson, instructors can also elicit feelings or views on genetic modification of the kalo plant. Lastly, instructors should review math concepts and reiterate the application and interwoven nature of math to history and culture.

Reference

Aufmann, R. N., Baker, V.C., Nation, R. D. (2011). *College Algebra and Trigonometry (7th ed.).* Belmont: Brooks/Cole, Cengage Learning

Cho, J. J., Yamakawa, R., & Hollyer J. (2007). Hawaiian Kalo, Past and Future. *University of Hawaiʻi at Mānoa, College of Tropical Agriculture and Human Resources SA-1.* Retrieved from: http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SA-1.pdf

Ebel, R.D., Mak, J. (1974). *Current issues in Hawaiʻi's economy.* Honolulu: Crossroads Press.

Kanahele, G.H.S. (1986). *Kū kanaka, stand tall: A search for Hawaiian values.* Honolulu: University of Hawaii Press.

Kelly, M. (1989). Dynamics of production intensification in precontact Hawaiʻi. *In What's New? A closer look at the process of innovation.* S.E. van der Leeuw and R. Torrence (eds), 82-106. London: Routledge.

Kirch, P.V. (1985). *Feathered gods and fishhooks: An introduction to Hawaiian archaeology and prehistory.* Honolulu: University of Hawaii Press.

Kirch, P.V., Rallu, J.L. (2007). The growth and collapse of pacific island societies: Archaeological and demographic perspectives.

Krauss, B. H. (1993). *Plants in Hawaiian Culture.* Honolulu: University of Hawaii Press.

Kupunakalo. (n.d.). Field visits: Outdoor classrooms on every island. Retrieved from: http://kupunakalo.com/index.php/site/field_visits

Lial M.L., Hornsby J., Schneider, D.I. (2009). *College Algebra (10th ed.).* Boston: Pearson Addison Wesley.

Nature (2009). *New technology reveals extent of early hawaiian agricultural systems: Thousands of farmed acres previously unknown to science identified.* Retrieved from http://www.nature.org/ourinitiatives/regionsnorthamerica/unitedstates/hawaii/newsroom/new-technology-reveals-extent-of-early-hawaiian-agricultural-systems.xml

Niesse, M. (2007, April 3). GMO taro pits Hawaiians against some scientists. *The Honolulu Advertiser.* Retrieved from: http://the.honoluluadvertiser.com/article/2007/Apr/03/br/br9725083614.html

Nonnecke, I.L. (1989). *Vegetable Production.* New York: Van Nostrand Reinhold.

Sheng, T.C. (1989). *Soil conservation for small farmers in the humid tropics.* Food and Agriculture Organization of the United Nations, Rome.

Name: _____   Date: _____

Kalo Activity Worksheet #1

Directions:

Taro Production Over Time
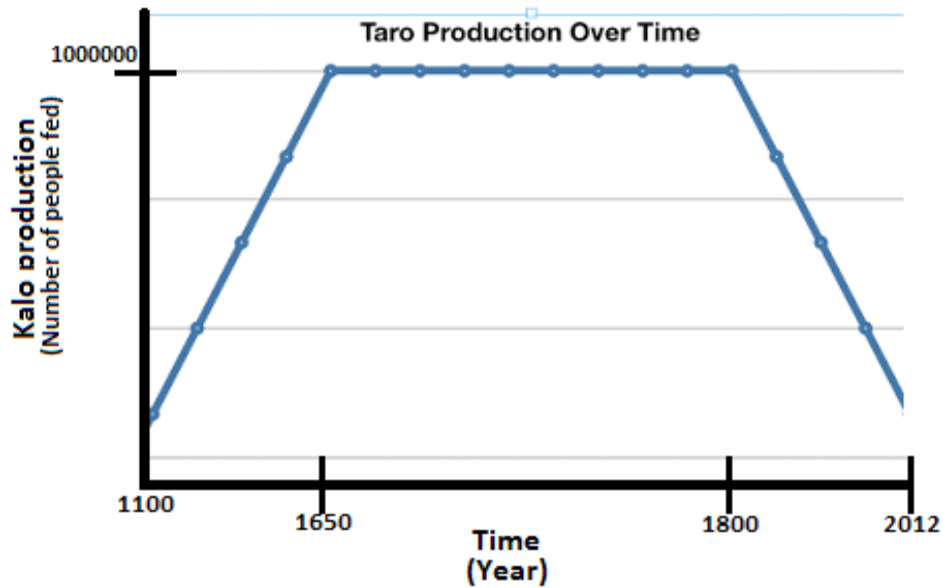
Based on what you learned in the lecture, what historical factors could account for the increase in taro production from the intervals of 1100 to 1650 years (x axis values).

_____

_____

From 1650 to 1800, the taro production and native Hawaiian population remained constant. Calculate the equation for the interval where the taro production remains constant.

_____

_____

Looking at the graph, the interval 1800 to 2012 (x axis) indicates a change in the graph. Name 3 events that occurred after the early 1800s that could explain this decrease.
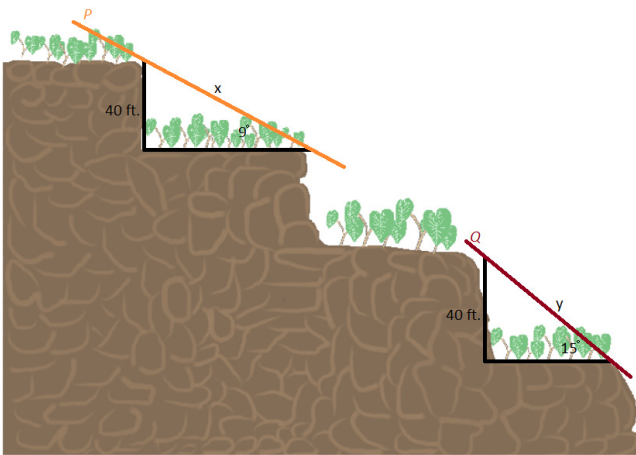
_____

_____

Kalo Activity Worksheet #2
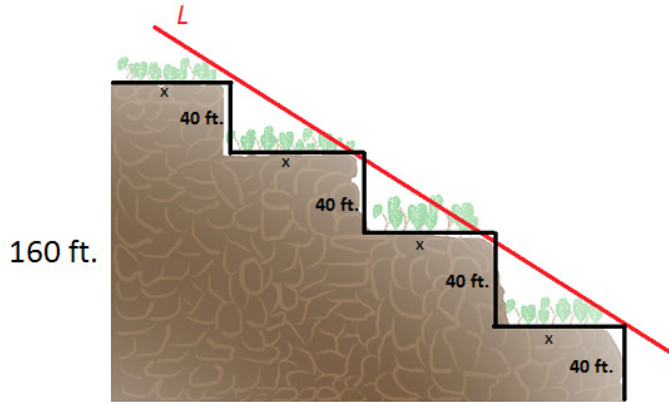
The height of the mountain from top to bottom is 160 feet. Each terrace is 40 feet in height. According to Sheng (1989), a suitable site for terracing would have an angle measurement between 7-25 degrees. a) Find the interval measurement of x. b) Find the interval of the slope of line *L*.
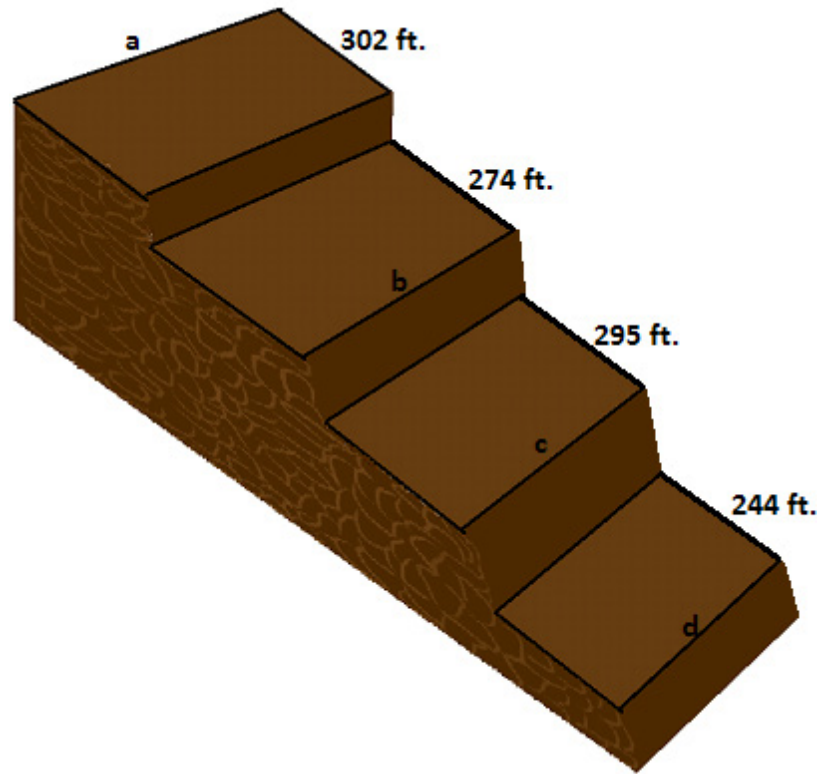
_____

_____

With a 9 degree angle measurement, what would the hypotenuse or value of x be?

_____

_____

What would the slope be of line P?

_____

_____

If we adjust the angle measurement to 15 degrees, what would the hypotenuse or value of y be?

_____

What would the slope be of line Q?

_____

Which line is steeper? Why? (Hint: compare the slopes)

_____

For every 43,560 square feet (1 acre), 25 people can be fed. If the four terraces are able to feed 100 people total, what is the length of a, b, c, d.

_____