‘O‘O IHE:

SPEAR THROWING AND REGRESSION

BY REBECCA AKAKA

What type of function (linear or quadratic) better correlates to a given data set?
How does one know which provides a better fit for the data?
How can one use linear or quadratic functions to predict the chances of hitting a target from a certain distance?

STANDARD BENCHMARKS AND VALUES

CCSS.MATH.CONTENT.8.SP.A.2 - Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

CCSS.MATH.CONTENT.8.SP.A.3 - Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

CCSS.MATH.CONTENT.HSS.ID.B.6 - Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

CCSS.MATH.CONTENT.HSS.ID.B.6.A - Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

CCSS.MATH.CONTENT.HSS.ID.B.6.C - Fit a linear function for a scatter plot that suggests a linear association.

CCSS.MATH.CONTENT.HSS.ID.C.7 - Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

CCSS.MATH.CONTENT.HSS.ID.C.8 - Compute (using technology) and interpret the correlation coefficient of a linear fit.

CCSS.MATH.CONTENT.HS.A-CED.1 - Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions...

- SMP #1: Make sense of problems and persevere in solving them
- SMP #4: Model with Mathematics
- SMP #5: Use Appropriate Tools Strategically
ENDURING UNDERSTANDING
Linear and quadratic functions can be used to model real-life situations.
There are different strategies to solve a problem, but some are more effective and efficient than others are; similarly some forms of regression better correlate to a given data set than others.

CRITICAL SKILLS AND CONCEPTS
PREREQUISITE KNOWLEDGE:
• Interpret real-world meaning of slope and y-intercept within a context.
• Identify independent and dependent variables
• Analyze and graph data using technology
• Evaluate and apply order of operations

STUDENTS WILL:
• Gain knowledge about the Makahiki season and its games, in particular ‘o’o ihe (spear throwing)
• Engage in the act of ‘o’o ihe (spear throwing)
• Gather and record data in tables
• Input, graph and interpret data, by hand and using TI-83 Calculators
• Apply knowledge of linear and quadratic equations to answer questions in context.
• Use problem solving skills and teamwork.

AUTHENTIC PERFORMANCE TASK:
1. Students will engage the Makahiki game of ‘o’o ihe (spear throwing) by throwing wooden dowels at targets (trees) outside the classroom.
2. Students will collect the data while spear throwing: distance and number of successful throws.
3. Graph the data collected into TI-83, and complete student worksheet, analyzing and comparing their data and graphs.

AUTHENTIC AUDIENCE:
Other ninth grade Algebra 1 students.

OTHER EVIDENCE:
Formative Assessments/Exit Pass; Benchmark Assessment; Accuracy of information

‘O’O Ihe: Spear Throwing and Regression

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LEARNING PLAN

DAY ONE: INTRODUCTION TO MAKAIKI

Students are introduced to the Makahiki season and Makahiki games.

Give students the handout “Makahiki Games: The Hawaiian Olympics”

Allow approximately 15 minutes to read the text and answer the questions.

Discuss the reflection questions (optional):

- Describe the purpose of Makahiki season.
  - To honor the God, Lono and to provide a break from wartime.

- What was the purpose of Makahiki games, besides entertainment?
  - Helped the warriors stay active and train for wartime, trained commoners in case they were called on to fight, provide opportunity for people to bring fame and honor to their families and ahupa’a.

- Choose at least two of the Makahiki games, and describe how these particular games would prepare or train a warrior.

Show video about how students at Halau Ku Mana Charter school observe and celebrate the Makahiki season. https://www.youtube.com/watch?v=8tUrHWYv5Yk

- Possible questions for discussion:
  - What games did you see them performing?
  - What other sort of activities were they doing and what skills were they learning?
  - In the video they said “Makahiki at Halau Ku Mana is a time for students and staff to reflect, learn, and have fun.” How is this similar [or different] from the ancient Hawaiians’ purpose for Makahiki?

‘O’O IHE ACTIVITY

Explain to students that they will have the opportunity to try their hand at one of the makahiki games, ‘o’o ihe or spear throwing. [activity adapted from mauikinesiology.com, see resources]

Materials for each group: ‘O’o ihe Data Worksheet, 1 wooden dowel, 1 tape measure or yard stick or meter stick.
Go over instructions for activity, before heading outdoors:

- Students will work in groups of 3-4.
- The objective is to hit a tree with their wooden dowel. Traditionally, you would have a sharp spear that sticks in the banana stump. For our purposes, if the dowel hits the tree, it is considered a successful throw.
- Each group will throw from 8 different distances, these distances are up to the students.
  - The minimum distance allowed to throw from target is 5 ft.
  - Each group will be given a tape measure or yard stick to measure their distance from the target (tree).
  - Whatever distance you choose, this means your feet should not cross that point. (Students used rules to mark the line they cannot cross while throwing.)
- Attempt 10 throws from each distance.
  Decide how many throws each person will attempt and stay consistent through-out the activity. For example, in a group of 3, person 1 might throw 4 times, while person 2 and 3 might throw 3 times each (4+3+3 =10).
- The distances and number of successful throws will be recorded in the table on the “‘o’o ihe data worksheet.”
- If groups finish early, have them continue working on the “‘O’o ihe Data Worksheet” by graphing their data and finding a line of best fit.
- Allow the last 5 minutes of class time for students to complete the ‘Reflection’ on the worksheet.
DAY TWO:

Start by reviewing what students learned and did the previous day. Students should have collected their data the previous day and completed their data table.

- **Optional:** If certain groups need more time, you may allow them to complete their spear-throwing and data collecting.

Students will complete the “‘O’o ihe Data Worksheet”

- Once students have collected their ‘o’o ihe data, they will graph their data, by hand, onto a coordinate plane. Students must label the axes and decide on an appropriate scale.

- Students will then draw a line of best fit and find an equation for their line of best fit.

- They must also identify their slope and y-intercept and what these key features represent in the context of the problem.

- Allow students to compare their answers within their own groups and then compare with at least one other group.

Students will then complete the student worksheet “Regression Worksheet” by inputting their data into the TI-83 calculators.

- Students used “Calculator Directions for Linear Regression” to guide them through the use of the graphing calculators.

- **Optional:** Allow several groups to present their findings to the class.

- Groups shared the following:
  1. The 3 lines of best fit they found by hand, and the linear and quadratic found by calculator.
  2. Which model fit the data the best and how they decided which model fit best.
  3. Which method they preferred (by hand or calculator) and why.
  4. Their favorite part of the lesson/activity or something they learned.

RESOURCES/REFERENCES

**Resources**

- “Makahiki Games: The Hawaiian Olympics” Text/Reading
- ‘O’o ihe Data Worksheet
- Regression Worksheet
- Instructions for Regression on TI-83
- Rubric

**References**

http://www.robertshawaii.com/blog/makahiki-games-hawaiian-olympics

https://prezi.com/cjdrntmgqpyt/oo-ihe-spear-throwing/

http://www.hawaiihistory.org/index.cfm?fuseaction=ig.page&PageID=520


https://apps.ksbe.edu/kawaiiloumoku/node/603
‘O‘O IHE DATA WORKSHEET

COLLECT YOUR DATA IN THE TABLE BELOW.

<table>
<thead>
<tr>
<th>DISTANCE</th>
<th>SUCCESSFUL THROWS</th>
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REQUIREMENTS:
- Attempt throwing from at least 8 different distances.
- Measure and record the distance, and the number of successful throws at each distance.
- Minimum distance: 5 feet.
- 10 attempts at each distance.
- Be consistent with the number of throws each person attempts at each distance.

GRAPHING BY HAND:
- Label and scale your x and y axes.
- Title your graph.
- Plot the points from your table.
- Draw a line of best fit for the points on your graph.
LINE OF BEST FIT
1. What is the equation of the line of best fit for your graph? Show your work or explain.

2. What is the slope of your line of best fit? What does it represent in the context of this problem?

3. What is the y-intercept of your line of best fit? What does it represent in the context of this problem?

REFLECTION QUESTIONS
4. If I had to explain what I did in math class today to a friend who was absent, this is what I would say...

5. What skills or knowledge did you gain during this lesson?

6. When I finished this lesson I felt... because...
Follow the directions on the “Calculator Directions for Linear* Directions” Worksheet. Once data has been entered and graphed, answer the following questions...

1. Derive a linear model for the data, rounding to the nearest thousandth.

2. Based on your linear model, what is the slope? What does it represent in the context of the problem?

3. Based on your linear model, what is the y-intercept? What does it represent in the context of the problem?

4. Use the linear model to predict the amount of successful throws from 41 feet. Does your answer make sense in context? Why or why not?

5. What is the value of the correlation coefficient, \( r \)? In general, what do correlation coefficient values indicate? What does this value tell us about this data in particular?

Fit a quadratic curve to the data... (On Step 3, instead of choosing, 4:LinReg, you will choose 5:QuadReg. Directions are the same from that point on.)

6. Derive a quadratic model for the data, rounding to the nearest thousandth.
7. What quadratic key feature can easily be identified from your quadratic model in #6? Does this make sense in context, why or why not?

8. Use the quadratic model to predict the amount of successful throws from 41 feet. Does your answer make sense in context? Why or why not?

9. What is the value of the correlation coefficient, (r)? In general, what do correlation coefficient values indicate? What does this value tell us about this data in particular?

Comparing models...
10. Which model fit the data better, the linear or quadratic? How do you know?

11. Compare and contrast your results with a different group. How are your results the same, how are they different?

12. Do you prefer to find the linear model (equation) by hand or using technology (graphing calculator)? Why?
Calculator Directions for Linear* Regression
(TI-83, TI-83 Plus, or TI-84 Plus)

BEFORE YOU BEGIN:
- Clear out (or de-highlight) any equations in the Y= editor (Y1, Y2, Y3, etc.)

STEP 1: Entering in the data into two lists (L1 and L2)
- Hit STAT
- Choose 1:Edit by either hitting 1 or ENTER.
  If necessary, clear out any old data in the lists:
  Use ④ to get cursor to cover L1 at top of list; press CLEAR ENTER. Repeat process for L2.
- Type the data values for the independent (x) variable in column L1. Hit ENTER after each entry.
- When you finished entering data in L1, hit ② and then enter the data values for the dependent (y) variable in column L2.

STEP 2: Making the scatterplot
- Hit 2nd Y= [STAT PLOT]
- Choose 1: Plot1 by either hitting 1 or ENTER.
- Turn On the plot by pressing ENTER.
  o Next to Type:, you should have selected □ (scatterplot)
  o For Xlist:, you should have L1
  o For Ylist:, you should have L2
  o For Mark:, you may choose any of the three options to represent the points on your scatterplot
- Hit ZOOM and choose 9: ZoomStat by scrolling down to 9 and hitting ENTER or by simply hitting ① to view the scatterplot.
  If the pattern of the data is appropriate for linear regression, continue with the following step.

STEP 3: Getting the regression equation (and storing it into the equation editor)
- Hit STAT then ② to CALC
- Choose 4:LinReg(ax+b) (Either scroll down to 4 and then hit ENTER, or simply hit 4)
- Hit VARS then ① to Y-VARS
- Choose 1:Function by hitting ENTER
- Choose 1:Y1 by hitting ENTER
- Hit ENTER

The coefficients of your linear regression equation (a and b) will be displayed on your homescreen. The linear regression equation will be stored in the equation editor in Y1.

*Note: The directions in Step 3 refer to linear regression. If a different type of regression is more appropriate, replace 4:LinReg(ax+b) with the more appropriate regression type found in the STAT ⑥ CALC menu.
MAKAHIKI GAMES: THE HAWAIIAN OLYMPICS

For Native Hawaiians, it wasn’t the lighting of a torch but the appearance of a star that signified the opening of the games. The appearance of the Makali‘i, also known as the Pleiades, in the eastern sky would mark the Hawaiian New Year and the start of the Makahiki (pronounced mah-kah-hee-kee) season. Makahiki was a time for the Hawaiians to honor Lono, the god of rain, agriculture, harvest, peace and fertility.

Ali‘i (chiefs) of each island traveled clockwise to the various ahupua‘a (or districts) holding Lono’s image atop a long pole collecting tributes for Lono as well as taxes from their tenants such as taro, sweet potatoes, dried fish, clothing and rare bird feathers. Some of these taxes were stored away as emergency supplies and some shared with lesser ali‘i, but most were redistributed and used for the celebrations. The journey around the island took several days and once all of the tributes to Lono and the ali‘i had been collected, the community gathered to celebrate. For four months warfare and unnecessary work were forbidden and instead the Hawaiian people enjoyed rituals, feasts, festivals and games.

The Makahiki games were the ancient Hawaiian version of the Olympics and contestants included trained athletes, ali‘i and commoners. These contests helped warriors to stay active, prepare for wartime and also served as training and practice opportunities for commoners in the event they were called on to fight in the future.

The winners of each ahupua‘a would be invited by the ali‘i to challenge the champions from other ahupua‘a and often had stories and songs written in their honor. Like the Olympics, these games encouraged good sportsmanship, friendly rivalries and gave people the opportunity to bring honor to their family and home district.

GAME ON

Ancient Hawaiians enjoyed a wide variety of games that showcased the mental and physical strength of the contestants. Some of the more popular and well-known games – many which are still played at events around Hawai‘i today – include:

- Konane is a two-person strategy game similar to checkers and is traditionally played with white coral and black lava on top of a carved stone. The board game starts with all of the holes or impressions filled in an alternating pattern of black and white. The players take turns hopping over one another’s pieces and capturing them. All moves must be capturing moves so the first player unable to make a capturing move loses.

- ‘Ulu Maika closely resembles American bowling but uses two stakes and a disc-shaped stone instead of pins and a bowling ball. The stakes are set in the ground a few inches apart with the goal of rolling the stone between the stakes.

- Moa Pahee or dart sliding is comparable to ulu maika but requires a little more strength and skill. Players attempt to slide a torpedo-shaped dart along the ground through the stakes, which are roughly 50 feet away and placed only a few inches wider than the darts apart. However, unlike ulu maika the dart cannot cross the line made by the stakes on their sides. The weight and less predictable path of the dart make this game more difficult.

- ‘O’o ihe, known as spear throwing, involves throwing various weighted spears into targets, traditionally upright banana logs, and showcases the accuracy required during battle as well as during food foraging.

- Kukuni is a foot race. In ancient Hawaii many of the top runners were later recruited by ali‘i as either messengers or spies.

- Huki huki is the Hawaiian form of tug of war during which two teams pull on opposite ends of the rope until the losing team is pulled over to their opponent’s side.

- Haka moa, or a standing chicken fight, is always a crowd favorite. Two players hold their left leg with their left arm and try to wrestle one another to the ground or out of a circle.

- Uma and pa uma are forms of hand wrestling. While pa uma is played standing upright with both feet planted on the ground, uma is played with both players lying on their stomachs with their elbows on the ground.

- Mokomoko or boxing was another popular Makahiki sport. Boxers challenged one another with bare fists and aimed for their opponent’s faces, with points being awarded for both hits and evasive moves.
MAKAHIKI GAMES: THE HAWAIIAN OLYMPICS

QUESTIONS FOR REFLECTION. Answer in complete sentences.

1. Describe the purpose of the Makahiki season.

2. What was the purpose(s) for Makahiki games, besides entertainment?

3. Choose at least two of the Makahiki games, and describe how these particular games might prepare or train a warrior for battle.

See more at: http://www.robertshawaii.com/blog/makahiki-games-hawaiian-olympics#sthash.w9f3S7cR.dpuf
RUBRIC FOR ‘O‘O IHE ACTIVITY

<table>
<thead>
<tr>
<th>UNSATISFACTORY</th>
<th>BELOW EXPECTATIONS</th>
<th>SATISFACTORY</th>
<th>ABOVE EXPECTATIONS</th>
<th>EXCEPTIONAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 3 points</td>
<td>4 – 6 points</td>
<td>7 – 8 points</td>
<td>9 points</td>
<td>10 points</td>
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<tr>
<td>• Performance does not meet specified expectations</td>
<td>• Performance is lower than specified expectations (poorly done).</td>
<td>• Performance matches specified expectations (fairly done).</td>
<td>• Performance is above specified expectations (well done).</td>
<td>• Performance well exceeds expectations (exceptionally done).</td>
</tr>
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<td></td>
<td>• The activity sheets were incorrectly completed.</td>
<td>• The activity sheets were completed, with several mistakes.</td>
<td>• The activity sheets were completed with very few mistakes</td>
<td>• The activity sheets were completed with no errors.</td>
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<td>• The guidelines were not followed.</td>
<td>• The guidelines were somewhat followed.</td>
<td>• The guidelines were mostly all followed.</td>
<td>• Guidelines were completely followed.</td>
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<td>• The information presented was neither comprehensive nor realistic.</td>
<td>• The info. presented was somewhat comprehensive and realistic.</td>
<td>• The info. presented was fairly comprehensive and mostly realistic.</td>
<td>• The information presented was comprehensive and realistic.</td>
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INDIVIDUAL GRADE
Use the rubric above to grade yourself: ____________
Teacher’s Grade: ____________
Teacher Comments:

INDIVIDUAL GRADE
Names of group members: ___________________________________________
Use the rubric to grade your whole group: ____________
Describe what worked well and/or did not work well with your group.