Explore/Explain Phase 3 - Ring Around the Tree

Purpose:
Explore data collection via the Internet. Participants will build both linear and quadratic models to describe the functional relationship from the collected data, and then use these models to make and verify predictions.

Descriptor:
Participants will gather data representing quadratic functions from the Internet such as data comparing the age of trees with the diameter of the tree. Participants will transfer their data from their computers to their graphing calculators, either by hand or using TI Connect. If tree ring data are used, participants will calculate the area of a cross-section of a slice of the tree trunk from the diameter and then create a scatterplot of area vs. age. Participants will then find a function rule to describe the relationship between the data sets and use this function rule in order to make and verify predictions.

During the Explain phase, the participants will use a spreadsheet to analyze the data and generate a scatterplot and function rule. During the debrief, participants will compare the use of the graphing calculator and spreadsheet to make the most judicious use of technology.

Duration:
2 hours

TEKS:

A.1A The student is expected to describe independent and dependent quantities in functional relationships.

A.1B The student is expected to gather and record data, or use data sets, to determine functional relationships between quantities.

A.1C The student is expected to describe functional relationships for given problem situations and write equations or inequalities to answer questions arising from the situations.

A.1D The student is expected to represent relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities.

A.1E The student is expected to interpret and make decisions, predictions, and critical judgments from functional relationships.

A.2A The student is expected to identify and sketch the general forms of linear ($y = x$) and quadratic ($y = x^2$) parent functions.

A.2B The student is expected to identify mathematical domains and ranges and determine reasonable domain and range values for given situations, both continuous and discrete.

A.2C The student is expected to interpret situations in terms of given graphs or create situations that fit given graphs.

A.2D The student is expected to collect and organize data, make and interpret scatter plots (including identifying positive, negative, or no correlation), and model, predict, and make decisions and critical judgments.
A.5A The student is expected to determine whether or not given situations can be represented by linear functions.
A.5B The student is expected to determine the domain and range for linear functions in given situations.
A.9A The student is expected to determine the domain and range values for which quadratic functions make sense for given situations.
A.9B The student is expected to investigate, describe, and predict the effects of changes in a on the graph of $y = ax^2$.
A.9D The student is expected to analyze graphs of quadratic functions and draw conclusions.

TAKS:

- **Objective 1:** Functional Relationships
- **Objective 2:** Properties and Attributes of Functions
- **Objective 5:** Quadratic and Other Nonlinear Functions
- **Objective 10:** Mathematical processes and tools

Technology:

- Internet access
- Spreadsheet technology
- Hand-held graphing calculator
- Graph link technology
- Word processing technology

Materials:

Advanced Preparation*:*

- Collect materials for each group
- Install TREE program onto calculators (optional)
- Participant access to computers with Internet capabilities, TI Connect, TI InterActive!, Excel, and Word
- Transparency Tree Growth

For the presenter:

- Overhead graphing calculator and overhead projector

For each participant:

- **Tree Ring Data Exploration—Parts 1-6** activity sheets
- **Ring Around the Tree Intentional Use of Data in the Classroom** activity sheet
- Graphing calculator with graph link

For each group of 2 participants:

- Computer
- Technology Tutorial
- Markers
- Tape to adhere chart paper to the wall

Explore

During this activity, participants will make predictions, gather data from a website, use that data to create graphs, and create mathematical models for relating the variables investigated. Participants will communicate their findings using a word processor, spreadsheet technology, TI InterActive!, and TI Connect software. If TI InterActive! software is not available, you can enter the data into the instructor's calculator and send it to the student calculators for analysis. If the TREE program is being used, install it on the students' calculators prior to beginning the activity. You can also send the program to calculators during the activity.

Leader Notes:

Introduction:

*Uncover the questions on the **Transparency: Tree Growth** one at a time.*
*Use the **Transparency: Tree Growth** to present the question: "Is there a relationship between the age of a tree and its cross-sectional area?" Participants should respond that a relationship exists. For example, they may respond with: as the age of the tree increases, the cross-sectional area increases.*

*Next, use the **Transparency: Tree Growth** to present the question: "If there is a relationship, how can the relationship be described mathematically?" Participants may respond "yes" and describe algebraic functions, such as linear, quadratic, exponential, etc, that represent the relationship. Ask participants what data they might want to collect to determine if a function relationship exists.*

Facilitation Questions

- How can you determine the age of a tree?
  Possible responses might include: Count the number of rings in its cross section. Grow the tree from seed and track the number of years it has been growing.
- What are some methods to determine the cross-sectional area?
  Possible responses might include: Measure the radius of each ring. Measure the circumference of the tree each year and calculate the cross-sectional area from that value.
- What are some advantages and disadvantages of these methods?
  Possible responses might include: Counting the tree rings involves cutting down the tree. Measuring over time requires a long time to collect data.

Since it is not practical to cut down a tree or grow a tree for this data analysis, ask participants where they might obtain the necessary data to answer the question. The Internet should be a suggestion in the discussion. If not, steer the discussion in that direction.

*Use the **Transparency: Tree Growth** to present the task, "If there is a mathematical relationship, sketch a prediction of the graph of the cross-sectional area versus the age of the tree. If there is not a relationship, explain why." Use strategy of think-pair-share to allow participants to share their thoughts with their small group and the whole group.*

Facilitation Questions

- What are the variables in this situation?
  Age and cross-sectional area
- Does a dependency relationship exist in this situation? If so, what is it?
  The cross-sectional area depends on the age of the tree.
- Are there units involved?
  Units might include years and square inches or square millimeters.

Refer participants to the Tree Ring Data Exploration participant page. Ask them to work through the exploration. The facilitator should circulate through the room assisting with the use of technology. They can reference the Tree Ring Technology Tutorial, Part 1: Exploring the Tree Ring Growth and Weather Website for assistance as well. If graphing calculators are the only technology available to participants then this portion of the activity can be done as a whole-group activity. The data will be sent to graphing calculators in a later activity.

Tree Ring Data Exploration

Part 1:

1. **Use the web browser feature in TI InterActive! to open the website http://vathena.arc.nasa.gov/curric/land/global/treegraf.html. Explore the site and investigate the data available. See the Tree Ring Technology Tutorial, Part 1: Exploring the Tree Ring Growth and Weather Website for assistance.**

2. **What data can you collect from this website?**
   Possible responses may include: tree growth versus year or age, tree growth versus precipitation, precipitation versus year, etc…

3. **In what formats are the data available?**
   HTML and Excel spreadsheet

4. **Which of the data sets available would be most helpful in answering the question, "Is there a mathematical relationship between the age of a tree and its cross-sectional area?" Why?**
   Participants should respond Growth of Tree in millimeters and year. At some point participants will need to determine the cross-sectional area. To do this, participants will need the radius of the tree. Knowing the growth each year will allow participants to calculate the radius of the tree for each year the data is examined.

Facilitation Questions

- What data are needed to answer the question?
  Age of the tree and cross-sectional area
- Does the data available need to be manipulated in any way to answer the question?
  Yes, Growth of Tree in mm must be converted to the radius of the tree.
- How can you determine the radius of the tree from the data?
  The radius is actually the cumulative growth of the tree at a particular year. Start with the growth of the tree at the initial year measured then add the growth of the tree each year until the final year measured.

Part 2:

1. **Import the data to the graphing calculator. See the Tree Ring Technology Tutorials, Part 2: Extracting the data, Preparing the data, and Exporting the Data to the Calculator.**
   Importing the data may take some time for participants to accomplish. The facilitator should move about the room assisting with the technology.

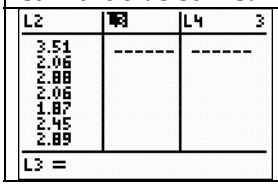
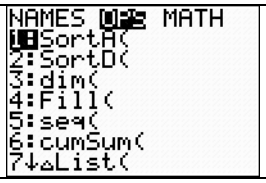
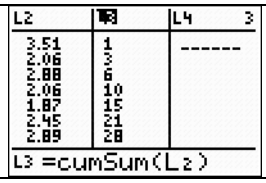
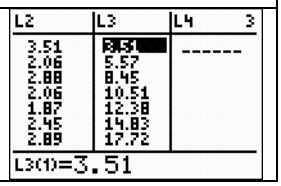
2. **Can you use the data in this form to determine the relationship between the age of a tree and its cross-sectional area? Why or why not?**
   No, the growth is listed as individual yearly measurements, not cumulative growth or the radius of the tree.

3. **How can you convert the individual yearly growth measurements to the radius of the tree at each year?**
   This question is asked in the previous section. Ask it again here to connect to the next question. The tree ring at the end of the first year is also the radius of the tree at the end of the first year. To find the succeeding radii, you must add the next tree ring width to the previous year's radius.

4. **How can you do this conversion with the graphing calculator?**
   They can do the conversion manually, use the cumSum command, or use a short program to convert the data.

Part 3:

1. **Convert tree growth to tree radius using the cumSum command.**

Press ▲ to the top of the list that will contain the cumulative sums.	**Press 2nd STAT. Press ▶ then 6 for the cumSum command.**	**Press 2nd then 2 for L2. Press ENTER.**	
			

2. **What do L1, L2, and L3 represent?**
   L1 is the age of the tree, L2 is the growth each year, and L3 is the radius of the tree.

3. **What is the domain of the data for this situation? What is the range of the data for this situation?**
   The domain is age of the tree in years, $[0,45]$. *The range for tree 1 is radius of the tree in millimeters,* $[0,101.53]$.

4. **How are the values in L1 (years of growth) changing?**
   The values in L1 are increasing by 1.

5. **How are the values in L3 (radius) changing?**
   Participants can estimate this change or they can use the ΔList *command. See the Tree Ring Technology Tutorial, Part 3: Rate of Change for assistance.*

6. **How can you describe the rate of change for this situation?**
   The rate of change fluctuates some but stays fairly constant over the entire data set.

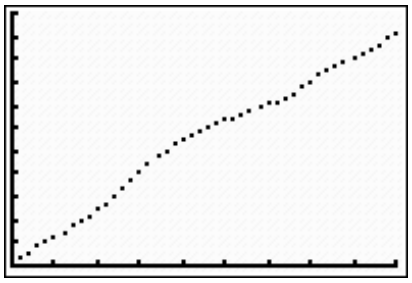
7. **What mathematical function would you choose to model the relationship between the age of the tree and the radius of the tree based on your knowledge of the rate of change for this situation?**
   A linear function would be the best choice to model the data in this situation.

8. **What is the average rate of change for this situation? What does this rate mean in the context of the problem?**
   $\approx 2.23\frac{mm}{year}$ *This is the average growth of the tree per year.*

Part 4:

1. **What do you predict the graph of the radius of the tree versus the age of the tree will look like? Why?**
   The graph of this data should be linear because the change in y (the radius) is changing at a fairly constant rate. The change in x (age) is steadily increasing by one.

2. **Graph the radius of the tree versus the age of the tree with the graphing calculator. See the Tree Ring Technology Tutorial, Part 4: Graphing the Radius of the Tree versus the Age of the Tree for assistance. Insert a screenshot of your graph below. How does the graph compare to your prediction?**

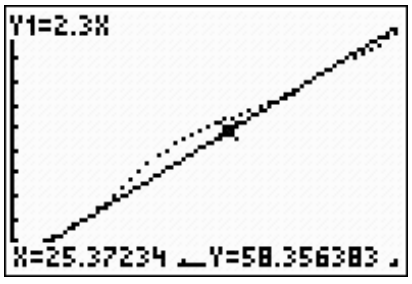


3. **What values did you choose for the graphing window and why?**
   The domain (x) could go from 0 to 45 to correspond with the ages of the tree. An x-scale of 5 would work well. The range will vary depending on the set of tree ring data that was chosen. The y-minimum will be 0 while the y-maximum will need to be a little larger than the longest radius in L3. A possible value for the y-scale is 10.

4. **Is there a correlation between the radius of the tree and the age of the tree? If so how would you describe the correlation?**
   Yes, a strong positive correlation exists between the radius of the tree and the age of the tree.

5. **What strategy could you use to determine a trend line for the data?**
   A trend line for this data can be found by starting with the parent function of y=x and changing the coefficient a in y = ax to best fit the graph i.e. transforming the parent function to fit the data. Another strategy would be to start by inserting the average rate of change found earlier for a in y = ax and making minor adjustments.

6. **Find the trend line and insert a screenshot of the graph below.**



7. **What would the radius of the tree be in 75 years?**
   For this set of data the radius would be ≈ 172.5 mm.

8. **How many years would it take for the diameter of the tree to reach 1 meter?**
   218 years for this set of data.

Part 5:

1. **Calculate the cross-sectional area for each year in a new list. See the Tree Ring Technology Tutorial, Part 5: Calculating the Cross-sectional Area for assistance.**
   You can calculate the area of the cross-section by typing the formula ($\pi * L3^2$) into L4 and allowing the calculator to do the work.

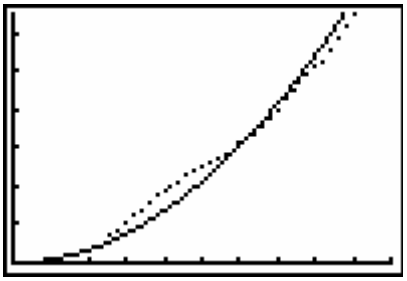
2. **Use stat plot 2 to create a graph of the cross-sectional area versus the age of the tree. See the Tree Ring Technology Tutorial, Part 5: Graphing the Cross-sectional Area versus the Age of the Tree for assistance. Insert a screenshot of your graph below.**
   Participants need to enter Stat Plot and turn off plot 1 and turn on plot 2 to save the previous work. X and Y will be L1 (age) and L4 (area), respectively. Participants will need to reset the window to fit the new data.

3. **Does a relationship appear to exist between the cross-sectional area of a tree and the age of a tree?**
   Yes, the relationship appears to be quadratic.

4. **How are the values in L4 (area) changing?**
   Participants can estimate this change or they can use the ΔList *command. See the Tree Ring Technology Tutorial, Part 3: Rate of Change for assistance.*

5. **How can you describe the rate of change for this situation?**
   The rate of change fluctuates some but is generally increasing over the set of data. The rate of change is changing which causes the graph of the function to curve.

6. **Estimate and graph a mathematical model for the relationship. Insert a screenshot of your graph below.**
   A line of best fit for this quadratic function can be found by starting with the parent function of $y = ax^2$ *and increasing the coefficient a to fit the graph i.e. transforming the parent function to fit the data. Another strategy would be to start by determining the second differences using the* ΔList *command twice, using one-half the mean of that result as the leading coefficient a in y = ax and making minor adjustments.*



Facilitation Questions

- What is the parent function of a quadratic relation?
  The parent function for a quadratic relation is $y = x^2$.
- What adjustments do you need to make to find a trend line?
  For $y = ax^2$ *when* $|a| > 1$, *the parabola will be "stretched vertically" For* $|a| < 1$, *the parabola will be "compressed vertically". The function needs to be stretched vertically to fit the data.*

7. **How can you determine the cross-sectional area of the tree when it is one hundred years old? What is the cross-sectional area of the one-hundred year old tree?**
   The cross-section area of a 100 year old tree would be approximately 171,813 mm^2 *for the data used in this example. This area can be found by using the table or trace feature on the graphing calculator or by evaluating the expression.*

8. **How old is the tree if the cross-sectional area is 0.5** m^2**?**
   $\approx$ *171.5 years*

9. **How did the model you developed in this section of the activity compare to your predicted sketch in the introduction?**
   Answers will vary.

Part 6:
Data Analysis Using Microsoft Excel

1. **Open the website http://vathena.arc.nasa.gov/curric/land/global/treegraf.html using Internet Explorer. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.**

2. **Can you use the data in this form to determine the relationship between the age of a tree and its cross-sectional area? Why or why not?**
   No, the growth is listed as individual yearly measurements, not cumulative growth or the radius of the tree.

3. **How can you convert the individual yearly growth measurements to the radius of the tree at each year?**
   The tree ring at the end of the first year is also the radius of the tree at the end of the first year. To find the succeeding radii, you must add the next tree ring width to the previous year's radius.

4. **How can you make this conversion with Excel?**
   Use a formula.

5. **Convert tree growth to tree radius using a formula in the spreadsheet. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.**

6. **What is the domain of the data for this situation? What is the range of the data for this situation?**
   The domain is age of the tree in years, $[0,45]$. *The range for tree 1 is radius of the tree in millimeters,* $[0,101.53]$.

7. **How are the values of the years of growth in column A changing?**
   The values are increasing by 1.

8. **How are the values of the radius in column D changing?**
   Participants can estimate this change or they can use a formula.

9. **How can you describe the rate of change for this situation?**
   The rate of change fluctuates some but stays fairly constant over the entire data set.

10. **What mathematical function would you choose to model the relationship between the age of the tree and the radius of the tree based on your knowledge of the rate of change for this situation?**
    A linear function would be the best choice to model the data in this situation.

11. What is the average rate of change for this situation? What does this rate mean in the context of the problem?

$\approx 2.23\frac{mm}{year}$ *This is the average growth of the tree per year.*

12. Create a chart that relates the radius of the tree to the age of the tree. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.

13. Does a correlation exist between the radius of the tree and the age of the tree? If so how would you describe the correlation?

Yes, there is a strong positive correlation between the radius of the tree and the age of the tree.

14. What will the radius of the tree be in 75 years?

For this set of data the radius would be ≈ 172.5 *mm.*

15. How many years would it take for the diameter of the tree to reach 1 meter?

218 years for this set of data.

16. Calculate the cross-sectional area for each year in a new column. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.

17. Create a chart that relates the cross-sectional area of the tree to the age of the tree. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.

18. How can you determine the cross-sectional area of the tree when it is one hundred years old? What is the cross-sectional area of the one-hundred year old tree?

The cross-section area of a 100 year old tree would be approximately 171,813 mm^2 *for the data used in this example.*

19. How old is the tree if the cross-sectional area is 0.5 m^2**?**

≈ 171.5 *years*

20. How did the model you developed in this section of the activity compare to your predicted sketch in the introduction?

Answers will vary.

Explain

This phase of the training should be a whole group discussion. Pose the following questions to participants one at a time, allowing enough time for meaningful discourse to take place about each question.

1. **What are some of the advantages and disadvantages of using archival data in this activity?**
   One possible advantage would be that the archival data allowed access to real-world data without timely and environmentally costly measures. One possible disadvantage is that the data required some manipulation before it could be analyzed to answer the initial question.

2. **What are some possible explanations for the variations in the data?**
   While the data appears to be fairly linear, it is not perfectly linear. This discrepancy may be due to periods of excess rainfall or drought.

3. **What might you do to verify your conjecture in question 2?**
   Return to the website and try to correlate to other variables such as rainfall.

4. **In what ways are the relationships, radius of a tree vs. age of a tree and cross-sectional area of a tree vs. age of a tree alike?**
   Both are dependent upon the age of the tree. Both use archival data. Both are increasing over time.

5. **In what ways are the relationships, radius of a tree vs. age of a tree and cross-sectional area of a tree vs. age of a tree different?**
   The rate of change of radius of a tree vs. age of a tree is constant. The rate of change of cross-sectional area of a tree vs. age of a tree is increasing. The relationship, radius of a tree vs. age of a tree can be modeled with a linear function. The relationship, cross-sectional area of a tree vs. age of a tree, can be modeled with a quadratic function.

6. **In what ways are the domain and range for the situation and the domain and range for the function rule used to model the situation, radius of a tree vs. age of a tree, alike?**
   The domain for the situation, radius of a tree vs. age of a tree is $[0,45]$. *The range radius of a tree vs. age of a tree is* $[0,101.53]$ *for the data set used in this example. The domain and range of the function used to model radius of a tree vs. age of a tree includes the values of the situation as a subset but is* (∞,∞) .

7. **How did you evaluate expressions in this exploration?**
   When given an age participants were asked to find a radius or a cross-sectional area.

8. **How did you solve equations in this exploration?**
   When given a radius or a cross-sectional area, participants were asked to find an age.

9. **Does the use of technology in this exploration reinforce pencil and paper symbolic algebraic manipulation? If so how? If not, what questions do you need to ask so that pencil and paper symbolic algebraic manipulation is reinforced?**
   Answers will vary. The point of this question is to stimulate discourse about the importance of teacher questioning regardless of the environment that students are working in, not to evaluate the use of technology or pencil and paper procedures.

Ring Around the Tree: Intentional Use of Data

TEKS	*A.1A, A.1B, A.1C, A.1D, A.1E, A.2A, A.2B, A.2C, A.2D, A.5A, A.5B, A.9A, A.9B, A.9D*	
Question(s) to Pose to Students	*What predictions can be made based on your model?* *What might change in the situation that would cause your model to become invalid?*	
Cognitive Rigor	Knowledge	*Identifying variables*
	Understanding	*Sketch a prediction of the graph of the relationship*
	Application	*Solve for the age given the radius.*
	Analysis	*What is different, what is alike …*
	Evaluation	*Does the use of technology in this exploration …*
	Creation	*What questions need to be asked…*
Data Source(s)	Real-Time	
	Archival	*Tree ring website data*
	Categorical	
	Numerical	*Bivariate data*
Setting	Computer Lab	*Students could explore the data site and data in small groups*
	Mini-Lab	*Students could collect the data then return to group and analyze the data*
	One Computer	*Whole class data exploration, teacher downloads data and sends the data to the student calculators*
	Graphing Calculator	*Teacher enters the data, sends the data to student calculators, and discusses the situation*
	Measurement Based Data	
Bridge to the Classroom	*Manipulated data from a website*	

1. *At the close of the Ring Around the Tree activity, distribute the Intentional Use of Data activity sheet to each participant.*

2. *Prompt the participants to work in pairs to identify those TEKS that received greatest emphasis during this activity. Also prompt the participants to identify two key questions that were emphasized during this activity. Allow four minutes for discussion.*
3. *As a whole group, share responses for two to three minutes.*

Facilitation Questions

- Which mathematical TEKS formed the primary focus of this activity?
- What additional math TEKS supported the primary TEKS?
- What Technology Applications TEKS are addressed during this activity?
- How do these TEKS translate into guiding questions to facilitate student exploration of the content?
- How do your questions reflect the depth and complexity of the TEKS?
- How do your questions support the use of technology?

4. *As a whole group, identify the level(s) of rigor (based on Bloom's taxonomy) addressed, the types of data, the setting, and the data sources used during this Explore/Explain cycle. Allow three minutes for discussion.*

Facilitation Questions

- What attributes of the activity support the level of rigor that you identified?

5. *As a whole group, discuss how this activity might be implemented in other settings. Allow five minutes for discussion.*

Facilitation Questions

- How would this activity change if we had access to one computer (one graphing calculator, CBR, etc.) per participant?
- How would this activity change if we had access to one computer (one graphing calculator, CBR, etc.) per small group of participants?
- How would this activity change if we had access to one computer (one graphing calculator, CBR, etc.) for the entire group of participants?
- How would this activity change if we had used graphing calculators instead of computer-based applications?
- How would this activity change if we had used computer-based applications instead of graphing calculators?
- How might we have made additional use of available technologies during this activity?
- Why was technology withheld during the prediction part of this activity?
- How does technology enhance learning?

6. *Prompt the participants to set aside the completed Intentional Use of Data activity sheet for later discussion. These completed activity sheets will be used during the elaborate phase as prompts for generating attributes of judicious users of technology.*

Transparency: Tree Growth

Can you determine a relationship between the age of a tree and its cross-sectional area?

If a relationship exists, how can you describe the relationship mathematically?

If a mathematical relationship exists, sketch a prediction of the graph of the cross-sectional area versus the age of the tree. If no relationship exists, explain why.

Participant Page

Tree Ring Data Exploration

Part 1:

1. **Use the web browser feature in TI InterActive! to open the website http://vathena.arc.nasa.gov/curric/land/global/treegraf.html. Explore the site and investigate the data available. See the Tree Ring Technology Tutorial, Part 1: Exploring the Tree Ring Growth and Weather Website for assistance.**

2. **What data can you collect from this website?**

3. **In what formats are the data available?**

4. **Which of the data sets available would be most helpful in answering the question "Is there a mathematical relationship between the age of a tree and its cross-sectional area?" Why?**

Part 2:

1. **Import the data to the graphing calculator. See the Tree Ring Technology Tutorials, Part 2: Extracting the data, Preparing the data, and Exporting the Data to the Calculator.**

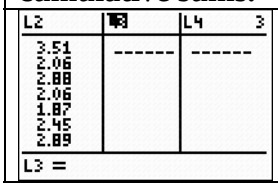
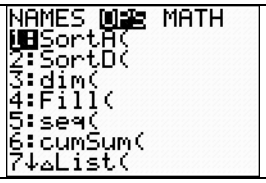
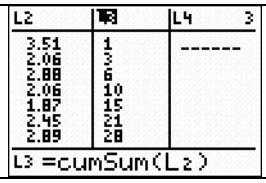
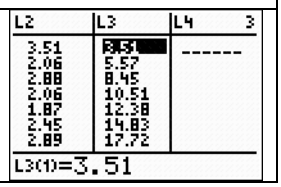
2. **Can you use the data in this form to determine the relationship between the age of a tree and its cross-sectional area? Why or why not?**

3. **How can you convert the individual yearly growth measurements to the radius of the tree at each year?**

4. **How can you do this conversion with the graphing calculator?**

Part 3:

1. Convert tree growth to tree radius using the cumSum command.

Press ▲ to the top of the list that will contain the cumulative sums.	**Press 2nd STAT. Press ▶ then 6 for the cumSum command.**	**Press 2nd then 2 for L2. Press ENTER.**	
			

2. What do L1, L2, and L3 represent?

3. What is the domain of the data for this situation? What is the range of the data for this situation?

4. How are the values in L1 (years of growth) changing?

5. How are the values in L3 (radius) changing?

6. How can you describe the rate of change for this situation?

7. What mathematical function would you choose to model the relationship between the age of the tree and the radius of the tree based on your knowledge of the rate of change for this situation?

8. What is the average rate of change for this situation? What does this rate mean in the context of the problem?

Part 4:

1. **What do you predict the graph of the radius of the tree versus the age of the tree to look like? Why?**

2. **Graph the radius of the tree versus the age of the tree with the graphing calculator. See the Tree Ring Technology Tutorial, Part 4: Graphing the Radius of the Tree versus the Age of the Tree for assistance. Insert a screenshot of your graph below. How does the graph compare to your prediction?**

3. **What values did you choose for the graphing window and why?**

4. **Is there a correlation between the radius of the tree and the age of the tree? If so how would you describe the correlation?**

5. **What strategy could you use to determine a trend line for the data?**

6. Find the trend line and insert a screenshot of the graph below.

7. What would the radius of the tree be in 75 years?

8. How many years would it take for the diameter of the tree to reach 1 meter?

Part 5:

1. **Calculate the cross-sectional area for each year in a new list. See the Tree Ring Technology Tutorial, Part 5: Calculating the Cross-sectional Area for assistance.**

2. **Use stat plot 2 to create a graph of the cross-sectional area versus the age of the tree. See the Tree Ring Technology Tutorial, Part 5: Graphing the Cross-sectional Area versus the Age of the Tree for assistance. Insert a screenshot of your graph below.**

3. **Does a relationship appear to exist between the cross-sectional area of a tree and the age of a tree?**

4. **How are the values in L4 (area) changing?**

5. **How can you describe the rate of change for this situation?**

6. **Estimate and graph a mathematical model for the relationship. Insert a screenshot of your graph below.**

7. **How can you determine the cross-sectional area of the tree when it is one hundred years old? What is the cross-sectional area of the one-hundred year old tree?**

8. **How old is the tree if the cross-sectional area is 0.5** m^2 **?**

9. **How did the model you developed in this section of the activity compare to your predicted sketch in the introduction?**

Part 6:
Data Analysis Using Microsoft Excel

1. **Open the website http://vathena.arc.nasa.gov/curric/land/global/treegraf.html using Internet Explorer. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.**

2. **Can you use the data in this form to determine the relationship between the age of a tree and its cross-sectional area? Why or why not?**

3. **How can you convert the individual yearly growth measurements to the radius of the tree at each year?**

4. **How can you make this conversion with Excel?**

5. **Convert tree growth to tree radius using a formula in the spreadsheet. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.**

6. **What is the domain of the data for this situation: What is the range of the data for this situation?**

7. **How are the values of the years of growth in column A changing?**

8. **How are the values of the radius in column D changing?**

9. How can you describe the rate of change for this situation?

10. What mathematical function would you choose to model the relationship between the age of the tree and the radius of the tree based on your knowledge of the rate of change for this situation?

11. What is the average rate of change for this situation? What does this rate mean in the context of the problem?

12. Create a chart that relates the radius of the tree to the age of the tree. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.

13. Does a correlation exist between the radius of the tree and the age of the tree? If so, how would you describe the correlation?

14. What will the radius of the tree be in 75 years?

15. How many years would it take for the diameter of the tree to reach 1 meter?

16. Calculate the cross-sectional area for each year in a new column. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.

17. Create a chart that relates the cross-sectional area of the tree to the age of the tree. See the Tree Ring Technology Tutorial, Part 6: Data Analysis Using Microsoft Excel for assistance.

18. How can you determine the cross-sectional area of the tree when it is one hundred years old? What is the cross-sectional area of the one-hundred year old tree?

19. How old is the tree if the cross-sectional area is 0.5 m^2?

20. How did the model you developed in this section of the activity compare to your predicted sketch in the introduction?

Ring Around the Tree – Intentional Use of Data

TEKS		
Question(s) to Pose to Students		
Cognitive Rigor	Knowledge	
	Understanding	
	Application	
	Analysis	
	Evaluation	
	Creation	
Data	Real-Time	
	Archival	
	Categorical	
	Numerical	
Setting	Computer Lab	
	Mini-Lab	
	One Computer	
	Graphing Calculator	
	Measurement Based Data	
Data Source(s)		