Investigation Station

Investigative Question: How tall is this tree?

Goal: Students will develop math and science process skills while estimating and measuring the height of a tree.

Objectives: Students will practice addition, multiplication, and division processes while comparing the differences between guessing, estimating, and using standard and non-standard measurements in determining tree height.

Knowledge: Guesses, estimates, and measurements are different ways of understanding the dimensions of something at varying degrees of specification.

Skills: Students will use tools to measure to the nearest half inch/foot or meter, compare objects using non-standard measurements, estimate length and height, add, multiply, and divide whole numbers, and practice rounding to the nearest whole number. They will also make and test predictions, then ask new questions based on their conclusions.

Values: Students will understand that a tree's life needs must be met over a long period of time for it to grow tall; they will appreciate the worth of estimation and measurement in different situations.

Virginia SOL: Science 3.1 Math 3.1, 3.4, 3.5, 3.6, 3.9, 3.17

Materials:

- At least one field tape with meters and feet per team of 4-5 kids
- Several Yard/meter sticks
- Large dry erase board & markers
- One small dry erase board for each team and markers
- Pin Flags
- Clinometer
- Calculator
- Post-its or other small pieces of paper
- pencils

Activity Prep:

1. Select a solitary tree that is at least twice as tall as your students, but if possible not much taller. If the tree is too tall for you to measure directly, use the clinometer to determine and record the actual heights of the tree (if a clinometer is not available, the height of a tree standing alone can be determined using the length of its shadow in a ratio with the length of the shadow of an object with a known height).
2. On the large dry erase board make a data table:

	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Total	Average
Guess								
Estimate 1								
Estimate 2								
Measure								

Procedure:

1. Ask students what they could measure about a tree. Record student responses on dry erase board for activity extensions. As students volunteer aspects that could be measured (how fat, how old, how tall, how wide, how thick, how many branches…) ask follow-up questions to expand their thinking: "what units would we use to measure that?", "what tool do we need to measure that", "describe how we could figure that out?"
2. Either guide or direct students into choosing to measure the height of the tree. As a class, decide what point on the tree will be considered the top, and whether to use either metric or U.S. Customary measurement.
3. In small groups, ask them to guess the height of the tree and write their guess on their team's dry erase board to share.
4. Record student responses on the large board in the "guess" row. As you get the information, ask each team to explain how they arrived at their guess. What clues did they use? Have them help you add up all student responses to get the "total", and then divide by the number of teams to get the "average". *Extension: have student groups line their dry erase boards in order. Compare the center points on the student created number line to the average. Discuss the lowest and highest guesses.*
5. Now ask students to name things that they *know* the height of. This could include people, objects, even animals. If they have trouble coming up with things, suggest measuring one of the students in the class or an object nearby.
6. Once several things of known height have been visualized, have the students compare the height of the tree to the height of the known thing. Ask, "how many _____ would you have to stack to get to the top of the tree?" Have each team work to decide how many _____ it would take, and then convert that number into units, showing their work on their dry erase board. For example, if it takes 3 and a half Alisas, and Alisa is 4 feet tall, then the tree is 14 feet tall.
7. As before, record student responses on the large board in the first "estimate" row. As you get the information, ask each team to share their math or explain how they arrived at their estimate. What clues did they use? Have them help you add up all student responses to get the "total", and then divide by the number of teams to get the "average". *Extension: have student groups line their dry erase boards in order. Compare the center points on the student created number line to the average. Discuss the lowest and highest estimates.*

8. Up to this point students have been guessing and estimating; it's time to measure. Ask students how to measure the height of the tree. Have the small groups talk to each other, making suggestions and pointing out some of the problems with the methods. After a few moments, gather together as a class and talk through some of their ideas. Most likely their methods will require unavailable tools or unsafe activities (ladders or climbing the tree). Offer the "bottoms-up" strategy as an alternative (see next step for strategy). *Note: if students have a viable measurement technique – DO IT!!!*
9. Give a flag to each student and have the students walk to where they think the top of the tree would rest if the tree were to fall down. Model standing with your back to the tree, and bend over to look between your legs (knees slightly bent – it should be a comfortable bend). Explain that you are looking for the place where you can just see the top of the tree through your legs, and that the distance from that point to the base of the tree is just about the same as the height of the tree. Describe what you see (either no top to the tree, or lots of space above the top) and ask the students if you should move closer to or further from the tree. Help them to understand that if there is space, they should move towards the tree. If they can't see the top, they should move away from the tree.
10. Have students try to find the place where they can see the tree through their legs as described. When they find that spot, they need to place the pin flag and then work with their team to find the distance from the base of the tree trunk to the pin flags and record all those distances on their white board.
11. Finding the average:
    a. Option 1- Have each team find their average, and record it on the class table as before.
    b. Option 2- This is a great time to model using a calculator. As a class, they have already practiced finding the average height twice. Now, they have many more numbers to average, and a calculator can do it very quickly. Whichever technique, ask the students if they think this method is accurate, and why or why not. *Extension: have student groups line their dry erase boards in order. Compare the center points on the student created number line to the average. Discuss the lowest and highest estimates.*
12. If time allows, help the students take the actual height of the tree using the clinometer OR the ratio method (described in step 1 of Activity prep). If not, reveal the actual height as measured prior to the activity. Ask students which of their predictions was closest and why.
13. Now that they know the height of the tree, what other questions do they have, what else could they investigate. Either distribute post-it notes or small pieces of paper and writing tools for students to write one question or experiment to try based on their discoveries in this activity, or explore possible extensions in a group discussion.