ESTABLISHING PURPOSE

1 **What are the key content standards I will focus on in this lesson?**

Content Standards:

TEKS Geometry Standards

(9) Similarity, proof, and trigonometry. The student uses the process skills to understand and apply relationships in right triangles. The student is expected to:

(A) determine the lengths of sides and measures of angles in a right triangle by applying the trigonometric ratios sine, cosine, and tangent to solve problems; and

(10) Two-dimensional and three-dimensional figures. The student uses the process skills to recognize characteristics and dimensional changes of two- and three-dimensional figures. The student is expected to:

(B) determine and describe how changes in the linear dimensions of a shape affect its perimeter, area, surface area, or volume, including proportional and non-proportional dimensional change.

(11) Two-dimensional and three-dimensional figures. The student uses the process skills in the application of formulas to determine measures of two- and three-dimensional figures. The student is expected to:

(C) apply the formulas for the total and lateral surface area of three-dimensional figures, including prisms, pyramids, cones, cylinders, spheres, and composite figures, to solve problems using appropriate units of measure; and

(D) apply the formulas for the volume of three-dimensional figures, including prisms, pyramids, cones, cylinders, spheres, and composite figures, to solve problems using appropriate units of measure.

TEKS Mathematical Process Standards

- Use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution.
- Select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems.
- Analyze mathematical relationships to connect and communicate mathematical ideas.

2 **What are the learning intentions (the goal and *why* of learning, stated in student-friendly language) I will focus on in this lesson?**

Content: To apply our understanding of trigonometric ratios and three-dimensional shapes to measure volumes and surface areas of real-world objects.

Language: To explain how to determine the volume and surface area of real-world objects using writing and diagrams.

Social: To help one another use appropriate tools—both physical and mathematical—to solve real-world problems.

3 **When will I introduce and reinforce the learning intention(s) so that students understand it, see the relevance, connect it to previous learning, and can clearly communicate it themselves?**

The learning intentions will be introduced as we walk outside to our learning site. Students will have them printed, along with the success criteria, on their task sheet so we can multitask our talking/reading/walking. We will converse about the goal, the tools we have, and some potential ideas. I'll loop back to the social intention as we engage in the measurement portion of the task outside. I'll revisit the language purpose as we conduct our write-up at the end of the day.

SUCCESS CRITERIA

4 **What evidence shows that students have mastered the learning intention(s)? What criteria will I use?**

I can statements:

- I can accurately measure angles of inclination with an inclinometer.
- I can measure heights of tall objects using trigonometry.
- I can model composite shapes using common 3-D shapes.
- I can apply my knowledge of surface area and volume to composite shapes.
- I can demonstrate my problem-solving process in writing.

5 **How will I check students' understanding (assess learning) during instruction and make accommodations?**

I will check in with the groups throughout the measurement portion of the task and assess through regular conversation. I will help students make sense of the inclinometers (digital or analog) and their readings as they practice with them.

We will also engage in a "planning phase" outside at the learning site before we jump into collecting measurements. During this phase, I will facilitate conversations within and between groups as we develop a collective understanding of which measurements we might need. I will emphasize the overcollection of data as being a better problem to have than the undercollection of data (i.e., if you think you might need it, measure it).

INSTRUCTION

6 **What activities and tasks will move students forward in their learning?**

Planning: During this phase, students will begin organizing their understanding of the problem itself and possible solution paths.

Additionally, they will start to determine which measurements they need to collect and which tools they should use for their collection. I expect students to experiment with measuring during this phase as well to see how various tools work.

Measuring: Students will use tape measures, inclinometers (both analog with protractors and digital with their phones), meter sticks, and string to determine various dimensions of the water tower they will be investigating.

Consolidating: Students will use their measurements and their knowledge of composite shapes to calculate the surface area and volume of the water tower.

Write-Up: In this phase, students will do a formal write-up of their work, explaining their process and solutions in words and with the help of diagrams they will generate.

7 **What resources (materials and sentence frames) are needed?**

1. Straws to attach to cell phones or tablets to make digital inclinometers
2. Level app that shows degree of tilt
3. Protractors, string, and weights to make analog inclinometers
4. Meter sticks
5. Measuring tape
6. String for measuring
7. Clipboards for outside work
8. Printed task sheets

8 **How will I organize and facilitate the learning? What questions will I ask? How will I initiate closure?**

The day will be organized in a linear fashion through the four phases previously listed:

1. Planning
    a. What are some dimensions of this water tower we might want to measure for future calculations?
    b. How might we go about measuring? Which tools should we use?

2. Measuring
    a. How does the inclinometer work?
    b. Have you taken multiple measurements of the same thing to check for accuracy?
    c. Are there any measurements you think you might need later, even if you aren't sure?
3. Consolidating
    a. How can we put all this together to start calculating surface area and volume?
    b. How can drawing a diagram help?
4. Write-Up
    a. Is your solution clearly stated for the reader?
    b. How can you organize your explanation of your process so that the reader could replicate it if he or she wanted?
    c. How can the use of visuals help the reader make sense of your thinking and process?