Summer 2016

UTM High School STEM Workshop

**Workshop Facilitator**: Dr. Chris Caldwell

**Subject/Grade**: Tower of PISA, Pythagorean Theorem / High School

**Estimated time**: 1 hour

**Standard(s)**: Tennessee Math Standards (boldface added)

High School,

The Standards for Mathematical Practice, especially: 1. **Make sense of problems and persevere in solving them**, 2. Reason abstractly and quantitatively, and 3. Construct viable arguments and critique the reasoning of others.

2. 8.G.B.5: Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

3. G.SRT.B.5 & M2G.SRT.B.5: Use congruence and similarity criteria for triangles to solve problems and to justify relationships in geometric figures. (Also B.G.SRT.)

**Objective**: Determine the number of sides of an octagonal tower visible from various vantage points. Determine the closest one can be to the center of the tower and see exactly 1 side, 2 sides, 3 sides, . . . Determine the furthest one can be from the center of the tower and see exactly 1 side, 2 sides, 3 sides, . .

* I can use the Pythagorean Theorem to calculate unknown lengths of sides of a right triangle.

**Assessment**: Students enter answers in a table. These are numerical values which are either right or wrong.

**Motivating Students/Anticipatory SET**: Consider looking at the results of the 2012 PISA exam, showing the US ranked 24th in the world for reading and 36th for mathematics. We can do better than that. Let’s look at an example PISA problem.

Alternatively, consider looking at images of turrets on buildings such as the ones found at the following URLs. Ask, how many sides of the turret can you see?

<http://1.bp.blogspot.com/-IZd6USNiY_c/TcAqFjOkVZI/AAAAAAAAKc8/UjwtG-qLP2A/s1600/DSC03869-small.JPG>

<http://www.chainimage.com/images/carriage_house__tower-jpg-464111-bytes.jpg>

**Instructional procedures**:

* Students should initially work individually.
* Give each student a copy of the “Seeing the Tower” worksheet. Describe what they are to find, and point out that a person standing at a position looking at the tower is allowed to turn his or her head.
* Have students complete the worksheet.
* Allow students to compare their answers with a partner or small group.
* Ask a group to explain how to solve this problem of determining the number of visible sides. They should be allowed to draw pictures on a board to explain the procedure.
* Review the Pythagorean Theorem.
* Distribute the “How Far” worksheet to groups of students. Discuss what they are being asked to find.
* Have them complete the “How Far?” activity. Each student should complete a worksheet.
* Discuss solutions with the whole group. Have each group provide one of the answers and then describe how they found it.
* Collect the worksheets.

**Materials and Resources**: A copy of Dr. Caldwell’s notes “Tower of PISA”

One copy of the “How Many?” worksheet for each student. One copy of the “How Far?” worksheet for each student. Optional: rulers

**Questioning/Thinking/Problem Solving**:

* How would this problem change if the tower had four sides instead of 8?
* How would this problem change if the tower had six sides?
* How would this problem change if the tower had five sides?

Watch students’ use of the Pythagorean Theorem closely.

**Grouping**:

Complete the “How Many?” worksheet individually and then have students compare answers with a small group. Complete the “How Far?” worksheet as a small group and compare and explain answers with the whole group.

**Accommodations/Adaptations**:

For a vision impaired student, have a 3D model of the tower available, built perhaps out of modeling clay. Re-phrase the question as something like “For how many sides could you begin at position $×$, walk in a straight line, and touch the side without moving or reaching around the tower?” Have string, dry spaghetti, or rulers to form the straight lines.

**Closure:** Remind students that to see a side from a position, they must stand opposite the tower from the line containing that side. Remind students that they solved the problem using the Pythagorean Theorem even though the problem did not refer to a triangle (the worksheet shows a triangle, but the question refers only to the tower, not a triangle).

**Teacher Reflection:** To be completed after conducting the lesson.