MANCHESTER COLLEGE

Education Department

LESSON PLAN by Adam Pyle
Adapted from
http://www.reachoutmichigan.org/funexperiments/agesubject/lessons/energy/solardogs.html

Lesson: Solar Ovens and Circle Game

Length: 70 minutes

Age/Grade Intended: Algebra II

Academic Standard(s):
Standard 3 Quadratic Equations and Functions
A2.3.6 Solve equations that contain radical expressions.
Standard 4 Conic Sections
A2.4.1 Write the equations of conic sections (circle, ellipse, parabola, and hyperbola).
A2.4.2 Graph conic sections.

Performance Objectives:
Given two points the students will solve two equations containing radical expressions to find the distance between them with 100% accuracy.

Given a vertex and a focus, directrix, or axis of symmetry, students will write one equation of a parabola with 100% accuracy.

Given a center and radius, the students will write one equation of a circle with 100% accuracy.

Given the equation of a circle, the students will graph one circle with 100% accuracy.

Assessment:
The students will be required to submit both the lab sheet for the solar oven experiment and the log sheet for the circle game. The teacher will check the lab sheet to see that the students understand why the solar oven is even workable (this amounts to checking that students understand the definition of a parabola and its impact in the real world). On the log sheet for the circle game, the students are required to list their strategic moves (which are simply circles). The teacher will check the equation written based on the center and radius chosen. Finally the students will take a short quiz at the end of the period that covers the distance formula, parabolas, and circles.

Advanced Preparation by the Teacher:
The teacher will need to get several supplies for this lesson. Every group of three or four will need the following: a shoe box, three or four sheets of tin foil, a small square of posterboard, a hot dog, a marker whose color is different from other groups, six or seven balloons, a five gallon bucket filled with water, a funnel, and a measuring cup. The teacher will also need to make enough copies of the lab sheet for the solar oven experiment and the log sheet for the circle.
game. The teacher will need to let administration know that he or she plans to spend almost the entire class period outside. The teacher will also need to have the coordinate plan “map” of North Manchester laid out in the parking lot in areas where traffic is not anticipated; this will need to be done before hand. A quiz (including a modified version for ADHD students) needs to be created.

Procedure:

Introduction/Motivation:
Hold up a hot dog and ask students to describe how they would normally cook it. Then ask:
- What are some things we have learned about parabolas? (Knowledge, Comprehension)
- How can we cook this hot dog using our information about parabolas? (Analysis)

Then explain that the goal of today’s lesson is to construct a solar oven using ideas about parabolas and to play a game designed to reinforce the concepts of circles. The period will end with a brief quiz over the distance formula, parabolas, and circles.

Step-by-Step Plan:
1. First separate the students into groups of three (or four if necessary). This can be done simply by numbering off.
2. Lead the students outside to the school parking lot. The map of North Manchester used in lesson #1 should already be laid out in an area where traffic is not expected.
3. Distribute the following materials to each group: a long narrow box (a shoe box would work fine), tin foil, posterboard, and the lab worksheet that they will fill out.
4. Students should work on the lab as the teacher monitors and provides assistance where needed. Give the students about twenty minutes to complete the construction of the solar oven and the lab sheet. Help those groups who may be experiencing difficulty in the construction process.
5. As the groups work to construct to their solar ovens, assign each group a group number. Let the groups know their number as part of the monitoring process and tell them to write it at the top of their lab sheet.
6. As the groups finish building the solar oven, distribute hot dogs. Tell the groups to set up the hot dog and wait patiently for the next activity as the other groups finish. The hot dogs will be checked towards the end of the lesson to see if the solar oven was successful. Give those groups who have finished a logic puzzle to think about as they wait.
7. When all groups have finished and set up their hot dogs, take the groups over to the coordinate plane of North Manchester. Each group will be assigned a portion of the map that corresponds to their group number. A sample map has been provided with territories and number designations.
8. Before the groups begin the game at the coordinate plane, distribute the log sheet for the game, a marker (each group needs a different color), a handful of balloons, a five gallon bucket with water, a funnel, and a measuring cup for liquids to each group.
9. For the first part of the game, the groups will need to do a little exploration on their own. Therefore have the groups distance themselves from each other and do the first six steps on the log sheet.
10. When the groups have finished the first six steps of the game log sheet, have them return to the coordinate plane. Explain the rules of the game.
   a. Each group will be assigned the territory on the map that corresponds to their group number.
b. The purpose of the game is to take over other territories while defending your own. The winner is the group who still has the most of its territory at the end of three rounds.

c. At the start of each round, the groups will decide the region of the map for which they will aim. They can choose either to defend their own territory or take over parts of another group’s territory. They will write an equation for a circle that will approximate the splash zone region their water balloon will create. They must provide the center, radius, and equation for the circle. Each group will do this unbeknownst to the other groups.

d. Once each group has written an equation for the region of the map they are targeting, the groups will throw water balloons one at a time towards that region. The order in which the groups throw will be decided by random drawing done by the teacher before the game begins.

e. Once a group has thrown a balloon, they will draw a circular region that best approximates the splash zone created by the balloon. This coloring will be done in the color marker they have received.

f. The circle should be drawn around the region that the balloon actually hits on the map and not the region the groups intended to hit when they wrote their circle equation.

g. At the end of three rounds the class will decide with help which group still controls the most of their territory. The areas of the territory still controlled are those where there is no color and those colored in the group’s color (an effort of defending in the territory).

11. Once the game is finished, the students should check on the hot dogs they were trying to cook in their solar ovens and finish the lab sheet for the hot dog lab.

12. Have the students submit both the lab sheet and the strategy log sheet for the game. Then return to the classroom.

Closure:
Ask the students the following questions:

- How has your understanding of parabolas and circles been enriched today? (Evaluation)
- Why did we have to be extremely precise when constructing the solar oven? (Comprehension)
- Were the circles a good approximation of the splash zone created by the water balloons? If not, what sort of figure might have worked better? (Evaluation)

Tell the students that a circle is a special type of ellipse. This will be the focus of tomorrow’s lesson. Draw a rough ellipse on the board and ask the students if this may have worked as a better approximation to our splash zones. The period will end with a brief quiz over the distance formula, parabolas, and circles.

Gardner’s Theory of Multiple Intelligences:
Visual/Spatial: Constructing the solar oven, using the coordinate plane “map” of North Manchester to visualize where the circles might be the best strategy in the water balloon game, approximating the splash zone of the water balloon with a circle
Mathematical/Logical: Using the distance formula, writing equations for parabolas and circles, graphing parabolas and circles
Interpersonal: Working in small groups to construct the solar oven and plan strategic moves for the circle game

Bodily-Kinesthetic: Using hands to construct the solar ovens (Tactile)

Adaptations/Enrichment:
Students with ADHD tend to be easily distracted and get frustrated with long periods of lecture; the nature of this lesson should keep all students motivated and involved. Written rules to the circle game should be provided; the teacher can check-in with students to see if the directions are clearly understood. Put the ADHD student in a group with students whom you know can handle the tasks and materials in a responsible manner. The only problem I foresee concerns the water balloons. These could be a great release of frustration that the ADHD student experiences in the typical classroom setting and daily instruction. Yet these balloons could prove to be disastrous to the concentration the student would need to grasp what is really important in these activities. This includes the features of parabolas and circles. Students in the groups could be instructed to take turns in the throwing of the water balloons. It does not become a distraction and the ADHD student still gets to experience some of the fun. In the construction of the solar oven, the groups can be encouraged to determine and delegate certain responsibilities that are necessary to complete the project. Everyone feels a sense of responsibility and distractions are minimized. Finally the ADHD student can be given extra time on the quiz. The teacher can offer to let the student finish after school or the following morning if the student is unable to finish before the end of the period. Their quiz can be typed in slightly larger print and the specific tasks the students are expected to do can be underlined or written in bold.

Self-Reflection:
The following questions can be used to guide the reflection to be done after the lesson:

- Were students too wrapped up in throwing the water balloons that their understanding of circles was not enhanced?
- What is the most appropriate way to put students into groups that is both efficient and may actually contribute to their learning?
- The construction of the solar oven must be precise. Are the students able to do this with consistency? If it is not done, are they disappointed in the power of parabolas?
- Unfortunately the water balloon game has the potential to leave students a little wet. This would probably not be appropriate. How can this lesson still be done and yet avoid that problem?