**Unit 2: Investigation 6 (3 Days)**

**The Construction Game**

**Common Core State Standards**

G-CO.12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). *Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.*

**Overview**

This Investigation and the following one are based on the assumption that all students have access to dynamic geometry software such as Geogebra or Geometer’s Sketchpad (GSP). First we make a distinction between a drawing and a construction. The latter cannot be “messed up” by dragging one of the vertices. Then we make a distinction between constructions that can be made with any tool in the pull down menus and those that are only made with compass and straightedge. The latter are called “Euclidean” constructions since these were the only tools Euclid used. In this investigation, students work in pairs to devise Euclidean constructions. Once they are convinced by measurement that a construction meets the required conditions and that it is robust (unable to be messed up), they then write out the steps so that another student may replicate it.

**Assessment Activities**

**Evidence of Success: What Will Students Be Able to Do?**

* Understand the difference between a drawing and a construction
* Use Compass and straightedge tools with dynamic geometry software to create Euclidean constructions
* Write out the steps of a Euclidean Construction

**Assessment Strategies: How Will They Show What They Know?**

* Pairs of students will turn in their write up for one Euclidean construction (in lieu of an exit slip)
* The Journal Entry asks students to describe strategies they used in playing the Construction Game.

**Launch Notes**

Begin by demonstrating the difference between a drawing and a construction. Start with the task of constructing an equilateral triangle given one segment $\overbar{AB}$ as a side. Establish a point *C* and join it to *A* and *B*. Measure all three sides of ∆*ABC*. Now adjust *C* until it appears that *AC* and *BC* are both equal to *AB*. We have *drawn* what appears to be an equilateral triangle. However, we can easily deform this drawing by moving one of the vertices.

In contrast show how to construct an equilateral triangle using only compass and straight objects. The steps for the construction are shown in **Activity 2.6.2 Constructing an Equilateral Triangle**. (There are two versions: 2.6.2a for Georgebra, 2.6.2b for Geometer’s Sketchpad.)

**Teaching Strategies**

**Group Activity:** Students will work in pairs at a computer throughout this investigation. You may want create homogeneous pairs so that you can focus your attention on students who may need help getting started.

You may want to make sure students know how to access the compass and straightedge tools in in their dynamic geometry program. **Activity 2.6.1 Euclidean Construction Tools** is a brief introduction. (There are two versions: 2.6.1a for Geogebra, 2.6.1b for Geometer’s Sketchpad.)

Have students construct an equilateral triangle on their own following the steps indicated in **Activity 2.6.2** **Constructing an Equilateral Triangle**. Then have them work with their partner on any of constructions listed in **Activity 2.6.3. Construction Challenge.** Encourage them to experiment and not be afraid of failure. Since this is an open-ended assignment we have allotted three days for the investigation. Monitor their progress. Remind them that they may only use the Euclidean tools and that once they are confident their constructions are robust, they should write up the steps so that someone else may replicate it.

The constructions in Activity 2.6.3 are:

1. Triangle given the length of three sides (Be sure the sides satisfy the triangle inequality, which will be proved in Unit 3 Investigation 2)

2. Ray that bisects a given angle

3. Line perpendicular to a given line through a point on the line

4. Line perpendicular to a given line through a point not on the line

5. Perpendicular bisector of a segment

6. Angle that is congruent to a given angle

7. Line parallel to a given line through a point not on the line (This construction will be revisited in Unit 3 Investigation 3)

8. Square given the length of one side

9. An angle measuring 30°

10. An angle measuring 45°

There are two versions of this activity: 2.6.3a for Georgebra, 2.6.3b for Geometer’s Sketchpad.)

Students will work at different paces. Most students will not get to all ten constructions. On the last day of the investigation, you may want to take some time to have students share their work with the entire class.

Note: This activity is based on work by James Paniati, a teacher at Northwestern Regional High School in Winsted, CT. See his article in the Resource section below.

**Differentiated Instruction (For Learners Needing More Help)**

Be prepared to give students who are struggling hints to get them started. The first three are the easier ones and should be attempted first.

**Differentiated Instruction (Enrichment)**

Expect stronger students to take off on their own with this assignment. Check in on their progress from time to time.

In lieu of an exit slip have each pair of students select one construction to write up and turn in on the last day.

**Journal Entry**

What strategies did you discover that helped you play the “construction game” Look for students to describe false starts as well as what worked. One general strategy they should discover is that the circle tool is usually used more frequently than the straight object tools.

**Closure Notes**

Point out to the entire class that we have now discovered as many as ten Euclidean constructions. The question now arises, how can we be sure these constructions always work? That will be the topic of our next investigation.

**Vocabulary**

Construction

Drawing

Euclidean Construction

**Resources and Materials**

Geogebra or GSP

(possibly compass and straightedge)

Geogebra and gsp files for Activity 2.6.3

Paniati, James. Teaching Geometry for Conceptual Understanding: One Teacher’s Perspective. In Craine and Rubenstein, ed. *Understanding Geometry for a Changing World* (71st yearbook). Reston, VA: National Council of Teachers of Mathematics, 2009.

Activity 2.6.1a Euclidean Construction Tools (for Geogebra)

Activity 2.6.1b Euclidean Construction Tools (for Geometer’s Sketchpad)

Activity 2.6.2 Constructing an Equilateral Triangle

Activity 2.6.3a Construction Challenge (for Geogebra)

Activity 2.6.3b Construction Challenge (for Geometer’s Sketchpad)