**Unit 2: Investigation 7 (2 Days)**

**Proving That Constructions Work**

**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 follows up on the previous one. Students now prove the validity of some of the constructions they made in Investigation 6.

**Assessment Activities**

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

* Use compass and straightedge tools with dynamic geometry software to create Euclidean constructions
* Write out the steps of a Euclidean Cconstruction
* Use theorems to prove the validity of Euclidean constructions

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

* **Exit Slip** **2.7** asks students to complete the proof of a construction.
* Th**e Journal entry** asks students to explain how congruent triangles are used in the proofs of constructions.

**Launch Notes**

Begin with this brief video about Euclid’s *Elements*: <http://www.cloudbiography.com/bios/euclid.html>. You may pause at approximately 0:57 to show the figure Euclid uses in his first proposition in Book 1: the construction of an equilateral triangle.

Euclid’s propositions involved constructions as well as theorems. Each construction was accompanied by a proof showing why it works. In this investigation we will examine proofs of the constructions we made in the previous investigation

**Teaching Strategies**

**Group Activity**

Again have students work in pairs as they did in the previous investigation.

Each of these activities shows the construction contained in Book I of Euclid’s *Elements* and helps students complete the proof. If students discovered a slightly different construction in the previous investigation they should try to prove its validity using similar methods. Depending how far students progress, at least one of these may be assigned as homework on the first day.

**Activity 2.7.1 Construction of an Equilateral Triangle** (This construction is Euclid’s Proposition 1)

**Activity 2.7.2 Construction of an Angle Bisector** (This construction is Euclid’s Proposition 9)

**Activity 2.7.3 Construction of a Perpendicular to a Line at a point on the line** (This construction is Euclid’s Proposition 11)

**Exit Slip** **2.7** has students complete a proof of the construction in **Activity 2.7.3.**

**Activity 2.7.4 Construction of a Perpendicular to a Line from a point not on the Line** (This construction is Euclid’s Proposition 12)

**Activity 2.7.5 Perpendicular Bisectors** is designed to prepare students for the construction of a perpendicular bisector in the following activity. Students review the concept of perpendicular bisector, revisit properties of reflection, and identify pairs of triangles that will be used in the subsequent proof.

**Activity 2.7.6 Construction of the Perpendicular Bisector of a Segment** (This construction is Euclid’s Proposition 10)

**Activity 2.7.7 Construction of a Triangle Congruent to a Given Triangle** (This construction is based on Euclid’s Proposition 22. In Euclid’s construction three line segments are given. The construction works only when the given sides satisfy the Triangle Inequality, which will be discussed in Unit 3 Investigation 2.)

**Activity 2.7.8 Construction of an Angle Congruent to a Given Angle** (This construction is Euclid’s Proposition 23.)

Proof for construction of a line parallel to a given line through a point not on the line is deferred until Unit 3 Investigation 3. Construction of a square is proved in Unit 3 Investigation 4.

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

Have students who were unsuccessful in discovering their own construction, carry out the steps of the constructions shown in each activity.

**Differentiated Instruction (Enrichment)**

Challenge these students to write proofs for their own constructions before consulting the Activity sheets.

**Journal Entry**

How are congruent triangles used in the proofs of Euclid’s constructions? Give at least two examples. Look for students to reference a particular construction, cite a particular congruence theorem, and show how corresponding parts of congruent triangles are used.

**Closure Notes**

Close by having students consider the last two constructions assigned in the previous investigation. Most students will probably not have gotten to them. However, all should be able to figure out what to do. For a 30° angle, construct an equilateral triangle and bisect one of its angles. (Of course we have not yet proved that the angles of an equilateral triangle are 30°, but students can verify this by measurement.) For a 45° angle, construct perpendicular lines and bisect one of the right angles.

**Vocabulary**

Proposition (from Euclid’s *Elements*)

**Resources and Materials**

Geogebra or GSP

(possible compass and straightedge)

<http://www.cloudbiography.com/bios/euclid.html> (video for launch)

<http://aleph0.clarku.edu/~djoyce/java/elements/bookI/bookI.html#props> (for Book 1 of the *Elements* on line)

Activity 2.7.1 Construction of an Equilateral Triangle (proof)

Activity 2.7.2 Construction of an Angle Bisector (proof)

Activity 2.7.3 Construction of the Perpendicular Bisector of a Segment (proof)

Activity 2.7.4 Construction of a Perpendicular to a Line at a Point on the Line (proof)

Activity 2.7.5 Construction of Perpendicular to a Line from a Point not on the Line (proof)

Activity 2.7.6 Construction of a Triangle Given the Lengths of Three Sides

Activity 2.7.7 Construction of an Angle Congruent to a Given Angle (proof)