Lesson Plans   CMST Institute

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Exploring Properties of Parallelograms Using Geometer's Sketchpad

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Exploring Properties of Parallelograms
Using Geometer's Sketchpad

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Grade level(s)/Subject taught: Mathematics 10 – 12

<u>Essential Questions</u>

- What are some of the important properties of parallelograms?
- How are rhombuses, rectangles, and squares similar and how are they different?

<u>Goals and Objectives</u>

Students will use Geometer's Sketchpad to:
- Construct a parallelogram by using only its definition;
- Calculate the measures of angles and segments;
- Use their findings to make and justify conjectures regarding relationships between angles, sides, and diagonals.

<u>Mathematical Concept</u> or "key idea" that modeling will be used to teach:

Students will:

- use visualization and spatial reasoning to analyze characteristics and properties of geometric shapes;
- identify and justify geometric relationships, formally and informally;
- build new mathematical knowledge through problem solving;
- make and investigate mathematical conjectures.

Materials: Geometer's Sketchpad

<u>Overview</u>

The lesson will begin with a review of the definitions of parallelogram, rhombus, rectangle, and square. Students often bring with them misconceptions about these figures based on inaccurate definitions they were given in elementary school. They often hold a very "narrow" or rigid view of these figures that prevents them from seeing the interconnections between them. For example they like to argue that a square is not a rectangle because "a rectangle has to be long and skinny," or that a rectangle is not a parallelogram because "a parallelogram has to be leaning to one side."

This is an inquiry based lesson in which students will build on their prior knowledge of parallelograms (namely the definitions) by discovering what geometric properties hold true for each one. After identifying these properties students will be able to see the hierarchy that exists between these figures. For example, the fact that every square is a rectangle but not every rectangle is a square. Students will be taught the basic functions of Geometer's Sketchpad including how to construct parallel lines. Students will work in pairs in a computer lab. The teacher will walk around to monitor students' progress and address any problems with the software.

<u>Procedure</u>

Students will follow detailed instructions to construct a parallelogram. They will measure the lengths of sides, diagonals, and angles. They will drag its vertices and sides to form a rhombus, rectangle, and square. In each case they will test to see which of the nine properties listed in the table below hold true.

Make sure you follow directions carefully!

Part 1: Construct parallelogram *ABCD*.

1. Use the segment tool to construct segment *AB* and *BC*.

2. Using the pointer tool, highlight point *A* and segment *BC*. Construct a parallel line.

3. Using the pointer tool, highlight point *C* and segment *AB*. Construct a parallel line.

4. Using the pointer tool, highlight the two lines you constructed and construct a point at the intersection.

5. Using the pointer tool, highlight the two lines. Use the Display menu to hide the lines.

6. Construct segments *AD* and *DC*.

Part 2: Measure the lengths of the sides and the angles of the parallelogram.

Call your teacher to check your work before moving on to the next section.

Part 3: Construct the diagonals of the parallelogram and measure their lengths.

7. Construct a point at the intersection of the diagonals.

8. Measure the four angles formed at point *E*.

9. Manipulate your parallelogram until you have a rhombus. PRINT

10. Manipulate your parallelogram until you have a rectangle. PRINT

11. Manipulate your parallelogram until you have a square. PRINT

Part 4: For each type of quadrilateral below determine which properties a true and check the appropriate boxes.

Property	Parallelogram	Rhombus	Rectangle	Square
All sides are congruent.				
Opposite sides are congruent.				
Opposite sides are parallel.				
Opposite angles are congruent.				
All angles are right angles.				
Diagonals bisect each other.				
Diagonals are congruent.				
Diagonals are perpendicular.				
Each diagonal bisects opposite angles.				

Expected Screenshot of Student Work (Also see attached GSP file)

Assessment (Rubric)

Category	1	2	3

Use of Geometer's Sketchpad Software	Did not use GSP to model the problem.	GSP was used but the data generated was not used effectively.	GSP was used effectively, including appropriate measurements and calculations.
Use of model to make conjectures and test their validity	Conclusions are not consistent with the model and the evidence provided is irrelevant.	Conclusions may be inconsistent with the data generated by the model due to minor errors.	Able to describe the relationship between the changes made to the initial parameters and the resulting measurements.
Accuracy of Constructions	Many flaws in constructions or shows no understanding of the task.	Constructions are inaccurate or show partial understanding of the task.	Constructions are accurate, well organized, and demonstrates full understanding of the task.
Application and understanding of geometric concepts	Does not show any understanding of the relationship between the model and the geometric concepts being studied.	Partial understanding of the geometric concepts and the implications of the activity.	Fully understands the geometric concepts, is able to make generalizations, and can apply the results of the activity.