Quadrilaterals

I. UNIT OVERVIEW & PURPOSE:

The goal of this unit is for students to understand the definition of special quadrilaterals and their properties. Students will learn the importance of constructing the quadrilateral accurately according the properties of the quadrilateral.

Quadrilaterals are in our everyday life and are often relied up in construction and design. The application projects require students to think about manipulating the shapes to fit a design. In each application project, students must construct the shapes to reinforce construction skills.

In this five-lesson unit, students will generate their own definitions of special quadrilaterals. Classroom definitions will be agreed upon to use for the rest of the unit. Students will next explore using Geogebra to list the properties of the quadrilaterals. We then have a design project where students must create an accurate diagram to apply shadowbox molding in a room and staircase. Finally, students will use the special quadrilaterals to design and create their own quilt.

II. UNIT AUTHOR:

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III. COURSE:

Mathematical Modeling: Capstone Course

IV. CONTENT STRAND:

The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

V. OBJECTIVES:

At the end of this unit…

1. Students will understand and know the definitions of parallelograms, rectangles, squares, rhombi, trapezoids, isosceles trapezoids, and kites.
2. Students will understand that a shape can be more than one of the special quadrilaterals.
3. Students will know the properties of the special quadrilaterals.
4. Students will use properties of special quadrilaterals to construct the shape.
5. Students will make connections between the geometric material included in the lesson and real-life cases of using special quadrilaterals.

VI. MATHEMATICS PERFORMANCE EXPECTATION(s):

MPE.4 Verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real world problems.

VII. CONTENT:

Students will generate their own definitions to the special quadrilaterals and discover the properties of the special quadrilaterals. Students will then use the properties of the quadrilaterals for real life design situations.

Lesson One: Definitions

Warm Up: Give a pre-assessment to the students to see their knowledge on quadrilaterals. Definition day: Give kids print outs of examples and non-examples of each type of quadrilateral. Students must create their own definition. We will decide as a class the accepted classroom definition. Give students a quadrilateral scavenger hunt, they must take pictures or sketch a picture of the real life example of the quad and list 4 reasons why they knew it was that shape. Homework: Finish quadrilateral scavenger hunt

Lesson Two: Properties

Warm Up: Quadrilateral Family Tree. Lesson: Geogebra – Each member in the group constructs 2 of the shapes to discover properties of the shapes. Each group will choose one of the shapes to sign up to make a poster about, then present poster to class. Posters will hang in classroom to remind students the properties of the shapes. Homework: 5-10 questions on using properties with angles/side lengths

Lesson Three: Shadowbox Molding

Warm Up: Create a sheet with each type of quad. Each group needs to pass around the paper to add one property to a quad. Lesson: Paneling on walls/staircase – Rectangles and Parallelograms. Give students a picture of a room & staircase without molding. Show pictures of the molding that we'll be applying to the walls. With a partner, students will create a diagram of how they will apply the molding. They will use tools to draw the molding on the diagrams. Class will vote on favorite. Homework: 5 – 10 questions

Lesson Four: Quilt Design

Warm Up: Watch the video at http://www.youtube.com/watch?v=hpNFqQl3KLI. Students need to write down 2 facts for each type of quadrilateral. Quilt Design – Students need to create a diagram of a quilt made out of quadrilaterals. The quilt must use all of the quads and needs to include measurements of sides and angles. Quilt needs to be a standard twin size. Bonus points will be awarded if the quilt design makes a figure.

Lesson Five: Paper Quilt

Warm Up: Play "What Am I?" Students have 10 yes/no questions to determine all of the quadrilaterals that describe the shape that the teacher is holding behind his or her back. Correct guesser gets to give the clues next time. Lesson: Paper Quilt – Students will use their design from lesson 4 to use construction paper to create a paper quilt. The students will use rulers, protractors, and compasses to insure their quadrilaterals are accurate. Paper quilts need to be exact tessellations with angles & sides labeled. Paper quilts need to be taped and turned in by the end of the block. Homework: Post Assessment (same assessment as used in lesson 1)

VIII. REFERENCE/RESOURCE MATERIALS:

Geogebra software, computer lab, document camera or LCD projector for modeling,

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markers, rulers, compasses, protractors, grid paper, poster boards and handouts

IX. PRIMARY ASSESSMENT STRATEGIES:

Observation: The teacher will observe students as the work on tasks to see if and where any additional help may be needed. Teacher will monitor, observe, and communicate with students as they work in groups.

Class discussion and participation: The teacher will engage student in discussion during the instructive portion of each lesson, monitoring for understanding.

Homework: Homework assignments will be given after the lessons. The homework will be discussed as a whole class. Handouts will be given to students during class with activities related to the lesson's learning objectives.

Pre and Post Assessment: Students will complete the pre assessment at the beginning of the unit and taken again at the end of the unit to measure growth.

Reflective Learning Logs: Students record their daily learning in a learning log at the end of class. Entries should include key concepts learned each day as well as record any remaining questions they want to bring up in the next class.

X. EVALUATION CRITERIA:

Students will be observed as they work during class. Whole class discussions will also help the instructor determine student knowledge. Final evaluation will be based off of the post assessment.

XI. INSTRUCTIONAL TIME:

Six 90 minute blocks

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Lesson 1 Sorting Quadrilaterals

Strand
Geometry

Mathematical Objective(s)
Students will be able to

- Apply the properties of rectangles and parallelograms.
- Demonstrate knowledge of special quadrilateral properties.
- Come up with a definition of their own for the quadrilaterals.

Mathematics Performance Expectation(s)
MPE.4) The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real world problems.

Related SOL
G.9 (The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.)
G-10 (The student will solve real-world problems involving angles of polygons.)
G-9 is the priority for this lesson.

NCTM Standards

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationship.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- Use visualization, spatial reasoning, and geometric modeling to solve problems.

Materials/Resources

- Computer
- Cell phone camera or camera
- ActivBoard

Assumption of Prior Knowledge

- This lesson builds on their prior knowledge of the properties of quadrilaterals.
- The student will recall the basic properties of quadrilaterals from their Geometry class.
- The students will discuss parallel lines, perpendicular lines, diagonals, bisector, congruent, right angle, alternate interior angles, symmetry, slope, distance, midpoint, and transversal.

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Introduction: Setting Up the Mathematical Task

- This lesson will investigate and analyze the different types of quadrilaterals, parallelograms, rectangles, rhombus, square, trapezoid, isosceles trapezoid, and kite.

- Time Line:
    - 15 minutes – Warm Up (Pre-assessment)
    - Divide into groups of 3
    - 5 minutes – Sort the quadrilaterals
    - 15 minutes – Create definitions
    - 20 minutes – Students share their definition and come up with a classroom definition
    - 35 minutes – Scavenger hunt

Student Exploration 1: Warm Up (Pre-assessment)

Individual Work: students will complete their pre-assessment individually

- Some questions to ask after pre-assessment:
    - What is a quadrilateral?
    - Name some types of quadrilaterals?
    - What are the rules for quadrilaterals? Parallelogram? Square? Rhombus? Rectangle? Trapezoid? Isosceles trapezoid? Kite?
    - How are the trapezoids and isosceles trapezoids similar? Different?
    - What makes the kite so unique and different from the other quadrilaterals?

Student Exploration 2: Quadrilateral Sorting / Definitions

Small Group Work:

- Students will be divided into groups of 3
- Have students sort the quadrilaterals, they will be given the special names (parallelograms, rectangles, rhombus, square, trapezoid, isosceles trapezoid, and kite.)
- Students will create their own definition for each special quadrilateral. Encourage students to be detail oriented when creating the definitions.

Whole Class Sharing/Discussion:

- Students will discuss how they sorted the quadrilaterals.
- Students will discuss the definitions that they were able to come up with.
- As a class create a list of all the rules for each of the quadrilaterals.

Student/Teacher Actions:

- Students will be sorting quadrilaterals

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- The teacher will be walking around and monitoring. The teacher will make sure they are working in the right direction. If the students aren't going in the right direction then the teacher needs to ask the students why they chose the name for the quadrilateral and try to get them back on the right track (by asking them questions) without giving them the answers.
- Students will share their definitions with the class.
- As a class the students will create a class definition.

Monitoring Student Responses

- Students will be writing down the rules.
- Students will talk to each other and ask each other questions about the shapes and what makes them the same and what makes them different.
- Students will create a chart with the names of the quadrilaterals along the top row and the first column will be the rules the students have come up with.
- Students that are having difficulty with the rules can be given some manipulatives.
    - Square – a square post-it note
    - Rectangle – sheet of paper
    - Isosceles trapezoid – create an isosceles triangle

    - Questions to pose to promote student thinking
        - What is the slope of the sides?
        - What is the length of the diagonals?
        - What do you know about the side measurements?
        - What do you know about the angle measurements?
        - Are the diagonals perpendicular?
        - Are the diagonals congruent?
    - Possible misconceptions or errors
        - Rhombus will be classified as a parallelogram or a kite.
        - Rectangles and squares will be switched.
        - Isosceles trapezoids will be classified as trapezoids only.
    - Questions to address those misconceptions or errors.
        - What are the measures of the sides?
        - What are the lengths of the diagonals?
        - Are the diagonals congruent?
        - Are the diagonals perpendicular?
        - Do the diagonals bisect each other?
        - Are the legs congruent?

Student Exploration 3: Quadrilateral Scavenger Hunt

- Have students return to their groups.
- Students will go on a scavenger hunt; they may go outside or stay inside.
- The students will need to find 7 pictures of each of the different quadrilaterals discussed today. At least one in each group will need to take their notes with them.
- The students will need to create a short slideshow presentation of the pictures that they found. The students may need to complete this assignment for homework.

Lesson 1 Assessment

- In lesson 1 students will sort the pictures of the quadrilaterals into their special name.
    - **Questions**
        - What is a quadrilateral? What are some special names of quadrilaterals?
        - What is a square? Rectangle? Trapezoid? Isosceles trapezoid? Kite? Rhombus?
        - Which shapes are similar? How are the square and rectangle similar? How are the square and rhombus similar?
    - **Homework**
        - Finish the Scavenger Hunt using their cell phone or camera to take the pictures, and create the slideshow presentation.

Extensions and Connections (for all students)

- The teacher will ask the students where they see quadrilaterals everyday.
- The teacher will ask students which types of quadrilaterals are used for building houses.

Strategies for Differentiation

- The students can draw the different types of quadrilaterals on construction paper and cut them out so they can create the diagonals and compare the sides.
- The students will create their own definitions about the different quadrilaterals, some can even draw the quadrilateral and label and mark the congruent parts.

Lesson 2 Quadrilateral Family Tree

Strand
Geometry

Mathematical Objective(s)
Properties of Quadrilaterals: Parallelograms, Rectangles, Rhombus, Square, Trapezoid, Isosceles Trapezoid, Kite. The student will identify each type of quadrilateral and create their own definitions of each one.

Mathematics Performance Expectation(s)

MPE.4) The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real world problems.

Related SOL

G.4a, c, f, g (The student will construct and justify the constructions of congruent line segments, a perpendicular to a given line from a point not on the line, an angle congruent to a given angle, and a line parallel to a given line through a point not on the given line.)

G.9 (The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems)

NCTM Standards
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationship.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- Use visualization, spatial reasoning, and geometric modeling to solve problems.

Materials/Resources
- GeoGebra
- Computer
- ActivBoard

Assumption of Prior Knowledge
- Students should have already explored parallel lines, perpendicular lines, alternate interior angle measurements, transversal, symmetry, slope formula, distance formula, and midpoint formula.
- Students should be familiar with the GeoGebra program.

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Introduction: Setting Up the Mathematical Task

- Introduce the lesson, as "Today we will be creating a family tree for the Quadrilateral family In this lesson we will use GeoGebra to construct two different quadrilaterals to discover the properties. Each group will make a poster of the quadrilateral and present it to the class."
- Time Line:
    - 20 minutes – Warm up / review
    - 10 minutes – Review the GeoGebra program
    - 30 minutes – Each group will construct 2 quadrilaterals
    - 10 minutes – Each group will create a poster using one of their shapes that they created in GeoGebra
    - 20 minutes – Poster presentation
    - If time allows, work on homework

Student Exploration 1: Review / Warm Up

Student/Teacher Actions:

- Have the students present their scavenger hunt slideshow presentation.
- Have the students discuss the pictures that are presented.

Monitoring Student Responses

- As the students are presenting their slideshow, be sure to ask questions referring to where the pictures were taken.

Student Exploration 2: Quadrilateral Family Tree

- Have students return to their groups. Once they are in their groups one student needs to take out their computer and go to the GeoGebra program. When all the groups have a laptop open, the teacher will review the program using the ActivBoard.
- Start this activity by sketching an outline of your own family tree (parents, siblings, and children). Tell them that they are going to create a family tree for the Quadrilaterals. The students are going to use the GeoGebra program to create 2 different quadrilaterals.

Student/Teacher Actions:

- The teacher will be walking around and monitoring the groups and making sure they are working in the right direction. If the students aren't going in the right direction then the teacher needs to ask questions to get them back on track and give some clues about the GeoGebra program.
    - Questions to pose to promote student thinking
        - What is the slope of the sides (they can use the axis and grid)?
        - What is the length of the diagonals (they can use the axis and grid)?
        - What do you know about the measures of the sides (they can use the axis and grid)?

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- What do you know about the angle measurements (they can use the angle measurement tool)?
- Are the diagonals perpendicular (they can use the angle measurement tool)?

Monitoring Student Responses

- Students will talk to each other and ask each other questions about the quadrilaterals and the GeoGebra program.
- Students will sign up for a quadrilateral and create a poster with the rules that go with the shape.

Lesson 2 Assessment

- **Questions**
  - Recall what is a square? Rectangle? Trapezoid? Isosceles trapezoid? Kite? Rhombus?
  - Which shapes are similar? How are the square and rectangle similar? How are the square and rhombus similar?
- Quadrilateral Poster
  - Students will create their poster and present it to the class. Each group will discuss the rules that are on their poster. The group will hang their poster for the class to refer to during this unit.

Extensions and Connections (for all students)

- The teacher will ask the students how the rules helped them with their constructions.
- The teacher will ask students which quadrilaterals are used to build houses and for playing different sports.

Strategies for Differentiation

- The students can use grid paper to create the construction on paper so it will be easier to construct in GeoGebra.
- The students will be able to walk around the classroom and see the different constructions and the rules that go with each of them.

Lesson 3: Shadowbox Molding

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Geometry

Mathematical Objective(s)
Students will be able to

- Use construction tools to construct rectangles and parallelograms.
- Apply the properties of rectangles and parallelograms.
- Demonstrate knowledge of special quadrilateral properties.

Mathematics Performance Expectation(s)
MPE 4) The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

Related SOL
G.4a, c, f, g (The student will construct and justify the constructions of congruent line segments, a perpendicular to a given line from a point not on the line, an angle congruent to a given angle, and a line parallel to a given line through a point not on the given line.)

G.9 (The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems)

NCTM Standards

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationship.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- Use visualization, spatial reasoning, and geometric modeling to solve problems.

Materials/Resources

- Computer and Projector
- Warm-Up
- Wall/Stair print out (enlarge the image)
- Geometric Construction Instructions
- Compass
- Straightedge
- Ruler
- Protractor
- Markers, crayons, or colored pencils

Assumption of Prior Knowledge

- This is a construction exercise that builds upon the properties we learned in Lesson 2. Students should be familiar with the properties of rectangles and parallelograms.
- Students should know how to perform basic constructions: Perpendicular & parallel lines, congruent segments, congruent angles.

Introduction: Setting Up the Mathematical Task

- Introduce the material to the class: "Today we will use the properties we found yesterday. We will warm up reminding ourselves of the properties of the quadrilaterals. We will next check our homework. We will then apply the properties of the quadrilaterals by planning how to apply shadowbox molding."
- Time Line:
    - 10 minutes – Warm Up
    - 10 minutes – Go over homework
    - 10 minutes – Explain shadowbox molding
    - 25 minutes – Group work on shadowbox molding
    - 10 minutes – Students share their work
    - 5 minutes – Journal

Student Exploration 1: Warm Up

Student/Teacher Actions:

- Have students sit in their groups of 3 to 4 people. Give a warm up paper to each student.
- Instruct students they are to write down one property of a special quadrilateral. When everyone has written the property, students will pass your paper to the next person in the group. On that paper students will write another property. Students will continue rotating papers in their group until a person in the group cannot think of another property. Once this happens, that group is out. Continue until only one group remains. Have that group share their list with the class. Include possible solutions to the exploration, possible questions to pose to promote student thinking, possible misconceptions or errors, and possible questions to address those misconceptions or errors.
- Have that group share their list with the class. Remind students to keep the warm up in their binder.

Monitoring Student Responses

- Do not allow students to use their notes.

- Encourage students to read the properties listed by other students. Remind them that some properties apply to multiple quadrilaterals.
- Allow students to list properties that seem insignificant (Ex: A rectangle has 4 sides)
- Once the winning group has shared their list, ask if anything was missed.

Student Exploration 2: Shadowbox Molding

- Have students find a partner. Once partners are established, students need to take out their construction tools along with a protractor and ruler. Hand out the wall and staircase outlines.
- Explain to students that they will be molding experts today by planning out where molding should go in this room to add interest. Share with students the YouTube clip at http://www.youtube.com/watch?v=vm9pY09Z8CY. Note to students that they may use any sort of special quadrilateral as long as the design is aesthetically pleasing and a pattern is apparent.
- Instruct students that they are to label the molding lengths and angles. Use the scale at the bottom of the page to give life size measurements. All of the drawings must be exact.
- Once the drawings are completed, students should color in the walls to finish the design. Encourage students to be creative with their design.
- While students are working, rotate throughout the room to monitor their construction process. Assist struggling students.
- Once all of the students are finished, have the students share their work. While students are sharing their work, ask how they determined the measurements, what sort of constructions were used, how did they know that the work was exact, etc… Let the class vote on their favorite.

Assessment

- Describe and attach the assessments for each lesson objective.
    - **Questions**
        - How do you know this shape is a rectangle? Remember, you need to have exact constructions.
        - How did you determine the measurements?
        - What sort of constructions were used?
        - How did you know that the work was exact?
    - **Journal/writing prompts**
        - How else could you use the properties of quadrilaterals in home design?
    - **Homework**
        - 10 questions using properties of quadrilaterals

Extensions and Connections (for all students)

- If students finish early, allow the student to research how quadrilaterals are used in design.

- Ask students to recall if properties of quadrilaterals have been useful in any other home project they were involved in.

Strategies for Differentiation

- Challenge students to use shapes other that parallelograms and rectangles.
- Provide a print out of the script to the video for ELL students.
- Allow students who find constructions challenging to use tracing paper.

Lesson 4: Quilt Design

Strand
Geometry

Mathematical Objective(s)
Students will be able to

- Use construction tools to construct special quadrilaterals.
- Apply the properties of rectangles and parallelograms.
- Demonstrate knowledge of special quadrilateral properties.

Mathematics Performance Expectation(s)
MPE 4) The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

Related SOL
G.4a, c, f, g (The student will construct and justify the constructions of congruent line segments, a perpendicular to a given line from a point not on the line, an angle congruent to a given angle, and a line parallel to a given line through a point not on the given line.)

G.9 (The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems)

NCTM Standards

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationship.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- Use visualization, spatial reasoning, and geometric modeling to solve problems.

Materials/Resources

- Computer and Projector
- Grid Paper
- Geometric Construction Instructions
- Compass
- Straightedge
- Ruler
- Protractor
- Markers, crayons, or colored pencils
- *If available: A quilt with a geometric design as an example*

Assumption of Prior Knowledge

- Students need to be familiar with tessellations.
- Students should be able to use construction tools.

Introduction: Setting Up the Mathematical Task

- Introduce the material to the class: "Today we will be using the properties of quadrilaterals to express ourselves creatively. Quilts have been around for hundreds of years and serve as a functional piece of artwork. After we warm up and check our homework, we will design a paper quilt which we will create a life size version of tomorrow."
- Time Line:
    - 10 minutes – Warm Up
    - 15 minutes – Go over homework
    - 10 minutes – Explain the quilt design
    - 45 minutes – Partner work on quilt design
    - 10 minutes – Journal

Student Exploration 1: Warm Up

Student/Teacher Actions:

- Have students take out their journals. Have the students label the entry "Properties of Quadrilaterals Video". Inform students they need to write down at least 2 facts about each shape that were in the video.
- Play the video found at http://www.youtube.com/watch?v=hpNFqQl3KLI
- Have the students turn to a partner and share their list. Choose 5 facts to draw corresponding diagrams in their journals.

Monitoring Student Responses

- Be ready to pause the video to insure the students have enough time to read the speech bubbles that go along with the trapezoids.
- Have students share their diagrams with the class.

Student Exploration 2: Quilt Design

- Have students find a partner. Once partners are established, students need to take out their construction tools along with a protractor and ruler. Hand out grid paper to each group. Allow students who wish to work individually to do so.
- Explain to students that they are going to design a quilt that is made only out of the special quadrilaterals that we have been discussing. Every type of special quadrilateral needs to be used in the design.

- In quilt designs, shapes do not overlap and never have missing gaps. To insure that their design follows these guidelines, the students must label every side and angle. The finished design must fit a standard twin size (60" x 84"). Have students establish a scale they would like to use for their quilt. For example, 1cm = 4in or 1cm = 3in. You will notice that the dimensions of the quilt are divisible by 2, 3, 4, 6, & 12 to provide simple conversions and drawings. Many students will need multiple sheets of graph paper in order to accommodate their scale. Inform students if their design makes a figure, they will receive bonus points on their quilt grade.
- Once the drawings are completed, students should color the diagram according to the construction paper available for the next lesson. Encourage students to be creative with their design.
- While students are working, rotate throughout the room to monitor their construction process. Assist struggling students.
- Once all of the students are finished, have the students share their work. While students are sharing their work, ask how they determined the measurements, what sort of constructions were used, how did they know that the work was exact, etc… Let the class vote on their favorite.

Assessment

- **Questions**
  - What shape was the most difficult to incorporate in your design?
  - How do you know these angles will not leave any gaps?
  - What sort of constructions were used?
  - How did you know that the work was exact?
- **Journal/writing prompts**
  - You and a friend are building a square fence. Once you finish you notice that it does not look like a perfect square. What are a few ways you could check to see if the shape is or is not a square?

Extensions and Connections (for all students)

- If students finish early, have the student design a pillow case to go along with the quilt design.
- Ask students what other types of functional art use geometry properties.

Strategies for Differentiation

- Challenge students to not put the same exact shape over and over in the quilt.
- Provide a print out of the script to the video for ELL students.
- Allow students who find constructions challenging to use tracing paper.
- Remind students to use the grid lines to assist in the constructions.

- Suggest to struggling groups to draw the outline of the quilt according to their scale first, then fill in the quilt.

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Lesson 5: Paper Quilting

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Geometry

Mathematical Objective(s)
Students will be able to

- Use construction tools to construct special quadrilaterals.
- Apply the properties of rectangles and parallelograms.
- Demonstrate knowledge of special quadrilateral properties.
- Use properties of quadrilaterals to justify a pattern is a tessellation.

Mathematics Performance Expectation(s)
MPE 4) The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

Related SOL
G.4a, c, f, g (The student will construct and justify the constructions of congruent line segments, a perpendicular to a given line from a point not on the line, an angle congruent to a given angle, and a line parallel to a given line through a point not on the given line.)

G.9 (The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems)

NCTM Standards

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationship.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- Use visualization, spatial reasoning, and geometric modeling to solve problems.

Materials/Resources

- Computer and Projector
- Grid Paper
- Geometric Construction Instructions
- Compass
- Straightedge
- Ruler
- Protractor
- Scissors
- Tape

- Construction Paper

Assumption of Prior Knowledge

- Students need to be familiar with tessellations.
- Students should be able to use construction tools.

Introduction: Setting Up the Mathematical Task

- Introduce the material to the class: "Today we will be using the properties of quadrilaterals to express ourselves creatively. Quilts have been around for hundreds of years and serve as a functional piece of artwork. After we warm up and check our homework, we will design a paper quilt which we will create a life size version of tomorrow."
- Time Line:
    - 15 minutes – Warm Up
    - 15 minutes – Explain the paper quilt
    - 20 minutes – Draft quilt pieces
    - 40/60 minutes – Quilt Construction (broken over two class periods)
    - 10 minutes - Journal
    - 20 minutes – Post Assessment

Student Exploration 1: Warm Up

Student/Teacher Actions:

- Write down the types of special quadrilaterals on slips of folded paper.
- Pick one special quadrilateral. Inform the class they have 10 yes or no questions to determine what type of quadrilateral you selected. They are not allowed to ask "Is it a trapezoid".
- Have students write down their guess on a piece of paper, white board, or type in response system. Reveal the class hypothesis. Ask students how they determined the correct shape.
- Allow one of the students who determined the correct answer to take the teacher's role. Repeat 4 or 5 times.

Monitoring Student Responses

- All students need to have a guess written down before the class can move on.
- If students are struggling, act as a student by asking questions.
- If one student is having a hard time, suggest to the student a question that would make the answer more clear.

Student Exploration 2: Paper Quilt

- Have students find their partner from lesson 4 and pair up with another group – each group should have about 4 students.
- Explain to the students that they are going to make some of the quilt designs a reality today. The groups are to select one of the designs that were created yesterday and make a life size version of the quilt. Model to students how to convert from their scale drawing to a life size figure.
- The students must show the teacher that they understand the directions before getting to far into the construction. Instruct each student in the group to make one of the shapes needed for the quilt with the correct property markings. Once a group is finished, the teacher needs to approve the work before they are given permission to continue on.
    - While the teacher is checking the constructed shapes, look to see that at least 3 properties are indicated on each shape, check if the angles are the proper size and verify that the shape is to the correct scale according to the diagram.
- The groups will work together on constructing the quadrilaterals to scale on construction paper. They must show that the shape is exact by showing congruent markings, parallel markings, etc… Show that properties such as "the diagonals bisect on another" on the construction paper.
- Remind students to be conservative with the resources by trying to cut out as many shapes on one piece of construction paper as possible.
- Students should cut out all of the pieces, label each piece, and tape the paper together by the end of class.
- Have students share their work with the class. Hang the artwork in the classroom or hallway.
- If the class finishes with extra time, give students time to work on the post assessment.

Assessment

- **Questions**
    - Did you have to alter the design at all? Why?
    - Why did you select this design?
    - What was the hardest part of the quilt project?
- **Journal/writing prompts**
    - In the past week list 3 things you learned, 3 things you already knew that we covered, and 3 things you would like to go into more detail about.

Extensions and Connections (for all students)

- Ask students why it was important that we verify that each shape was exact.
- Ask students if they have ever made a quilt. If so, what sort of geometric design did they use?

Strategies for Differentiation

- Challenge students to not put the same exact shape over and over in the quilt.
- Group students who find constructions difficult with classmates who find it easier.
- Allow students who find constructions challenging to use tracing paper.

GEOMETRIC CONSTRUCTIONS INSTRUCTIONS

A Congruent Segment

1. For this construction, you will be given a segment and asked to construct a second segment which is congruent to the first.
2. Draw a ray on your paper.
3. Open up your compass so that its opening is the length of the given segment.
4. Without letting the compass slip, place your point on the endpoint of the ray.
5. Mark a small arc on the ray with the compass.
6. Draw a point where the arc and ray intersect.

The congruent segment begins at the ray's endpoint and ends at the point of intersection.

A Congruent Angle

1. For this construction, you will be given an angle and asked to construct a second angle congruent to the first.
2. Draw a ray on your paper.
3. Place the point of your compass on the vertex of the given angle.
4. Draw an arc that intersects both rays of the given angle.
5. Without letting your compass slip, place the point of your compass on the endpoint of the previously drawn ray and draw the same arc.
6. Go back to the given angle. Open your compass so that its opening extends from where the arc intercepts one side of the angle to where the arc intercepts the other side of the angle.
7. Go to your ray. Without letting the compass slip, place the point of your compass on the point where the ray and arc intersect.
8. Draw an arc that intersects the first arc.
9. Draw a ray beginning at the endpoint of the original ray and extending through the point of intersection of the two arcs.

You should now have an angle that is congruent to the given angle.

The Perpendicular Bisector of a Segment –"Fireworks method"

1. In this construction you will be given a line segment and asked to construct the perpendicular bisector of the segment.
2. Open up your compass so that the opening is about 3/4 as long as the segment.
3. Place the point of the compass on one endpoint of the given segment.
4. Draw an arc above the given segment.
5. Without letting the compass slip, place the point at the other endpoint of the given segment.
6. Draw arc above the given segment that intersect the previously drawn arcs.
7. Open up your compass so that the opening is larger.
8. Place the point of the compass on one endpoint of the given segment.
9. Draw an arc above the given segment.
10. Without letting the compass slip, place the point at the other endpoint of the given segment.
11. Draw arc above the given segment that intersect the previously drawn arcs.
12. Draw a line through these two points of intersection.

You should now have a line that is perpendicular to the given segment and bisects it.

Perpendicular Bisector of a segment – "Fish method"

1. For this construction, you will given a segment and asked to construct its perpendicular bisector.
2. Open your compass so the opening is more than half the length of the given segment.
3. Place the point of the compass on one endpoint of the segment and draw on long arc so it's on both sides of the segment.
4. Without letting your compass slip, place the point on the other endpoint of the segment and draw arcs on both sides of the segment.
5. Place points where the arcs intersect.

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6. Draw a line connecting the two points of intersection.
You should now have a line that is perpendicular to the given segment and that bisects it.

Parallel Lines – Corresponding Angles Method

1. For this construction, you will be given a line and a point P not on the line and asked to construct a second line which is parallel to the given line.
2. Draw a transversal that intersects both the point P and the given line.
3. Place the point of your compass at the point of intersection of the transversal and the given line.
4. Draw an arc that intersects both the given line and the transversal.
5. Place the point of your compass on the given point P on the transversal you drew.
6. Draw an arc with the same radius as before.
7. Go back to the angle formed by the transversal and the given line. (You will be copying this angle at point P)
8. Open your compass so that its opening extends from where the arc intersects the given line to where the arc intersects the transversal.
9. Go to the second arc drawn in step 6. Without letting the compass slip, place the point of the compass where the arc and the transversal intersect.
10. Draw another arc that intersects this arc.
11. Draw a line that passes through the given point P and the point of intersection of the two arcs.
You should have a line passing through point P that is parallel to the given line.

A Perpendicular Line from a Point Off of the Line

1. In this construction, you will be given a line and a point P not on the line and asked to construct a line perpendicular to the given line passing through the given point.
2. Place the point of you compass on point P.
3. Open up the compass so that you will be able to draw an arc that intersects the given line in two places. Draw this arc.
4. Without letting the compass slip, place the point on one of the intersection points.
5. Draw an arc on the opposite side of the line from point P.
6. Repeat steps 4 and 5 from the other point of intersection . This arc should intersect the last arc.
7. Draw a line that passes through point P and the point of intersection of these last two arc.

A Perpendicular Line through a point ON a line

1. In this construction, you will be given a line and a point on the line and asked to construct a line perpendicular to the given line at the given point.
2. Place the point of your compass on the given point on the line.
3. Open the compass and draw an arc that intersects the line in two places.
4. Open up the compass a little wider.
5. Place the point of the compass on one of the points of intersection and draw arcs on both sides of the line.
6. Without letting the compass slip, place the point on the other point of intersection and draw arcs on both sides of the line as before.

These arcs should intersect the previously drawn arcs.

7. Draw a line through these points of intersection and the given point
You should now have a line passing through the given point that is perpendicular to the given line.

Warm Up: Quadrilateral Properties

Fill in one property at a time. Try to be the group that lists the most properties.

Parallelogram

Trapezoid

Rectangle

Isosceles Trapezoid

Rhombus

Kite

Square

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Quadrilaterals Pre/Post Assessment **Name**_____

1. Describe in your own words what is a quadrilateral?

2. Give the name of the 7 special quadrilaterals.

_____ _____

_____ _____

_____ _____

_____

3. Which of the 7 special quadrilaterals have opposite sides that are parallel?

_____ _____

_____ _____

4. Which of the 7 special quadrilaterals have opposite sides that are congruent?

_____ _____

_____ _____

5. Which of the 7 special quadrilaterals have 4 right angles?

_____ _____

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6. Which of the 7 special quadrilaterals have opposite angles that are congruent?

_____ _____

_____ _____

7. Which of the 7 special quadrilaterals have congruent diagonals?

_____ _____

_____

8. Which of the 7 special quadrilaterals have diagonals that are perpendicular?

_____ _____

_____ _____

9. Which of the 7 special quadrilaterals have only one pair of parallel sides?

_____ _____

10. Which of the 7 special quadrilaterals have four congruent sides?

_____ _____

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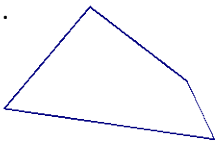
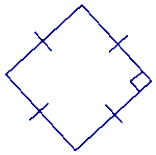
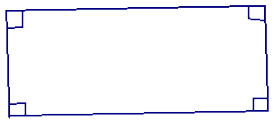
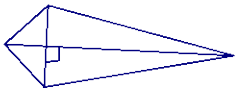
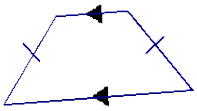
Quadrilaterals

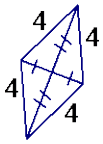
1. 

2. 

3. 

4. 

5. 

6. 

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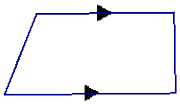
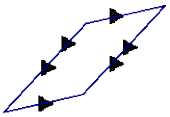
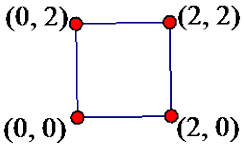
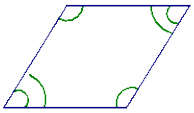
8. 

9. 

10. 

11. 

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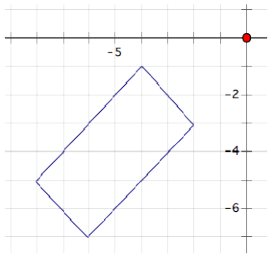
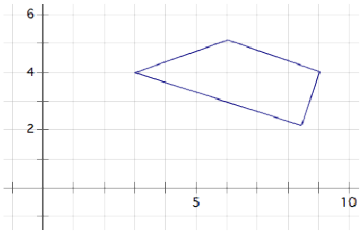
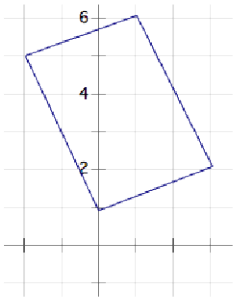
14. 

15. 

16. 

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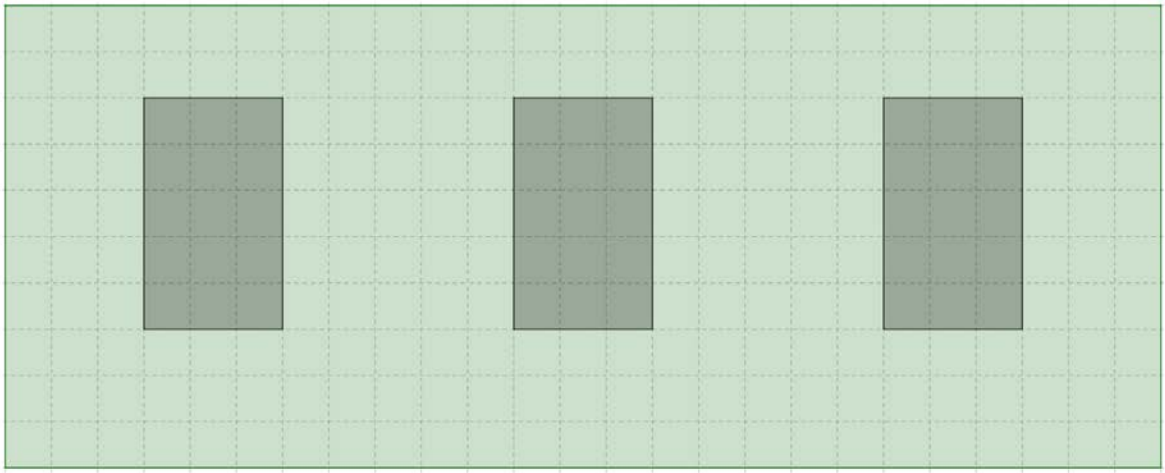
Wall #1
Each grid line represents 1 foot
Molding on each wall must match in style or show a pattern.

Wall #2
Each grid line represents 1 foot.
The darken rectangles are windows.
Do NOT put molding on top of the windows!!



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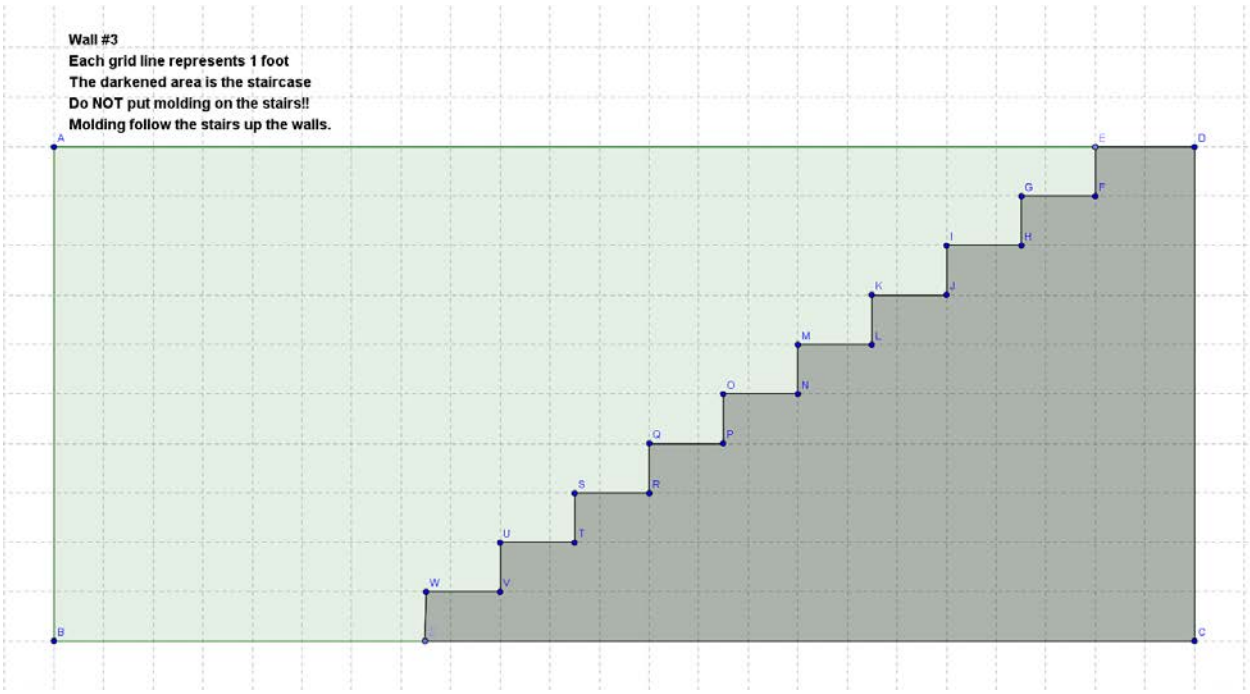

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