Building a House

I. UNIT OVERVIEW & PURPOSE:

In this unit, Building a House using Geometry, the students will construct a house using geometric strategies. Students will incorporate constructions, quadrilateral and triangle properties, and technology. The main goal of this unit is to show students how geometry is intertwined in real world applications. This unit will build upon the fundamentals of geometry. This unit will show students how each topic spirals and connects to the previous topic learned in Geometry. This unit will begin with students learning to construct quadrilaterals and triangles. As the unit progresses the students will have an opportunity to interact with community architects and county and/or city housing officials. As the unit proceeds the students will build their house by applying the concepts of topics learned in the course. Once students have completed the foundational lessons of this unit, they will then build their own house.

II. UNIT AUTHOR:

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III. COURSE:

Mathematical Modeling: Capstone Course (the course title might change)

IV. CONTENT STRAND:

Geometry

V. OBJECTIVES:

Students will construct a variety of triangles and quadrilaterals using a compass and straight edge as well as computer software (Geometer's Sketchpad or other similar dynamic software).

Students will identify the properties of triangles and quadrilaterals.

VI. MATHEMATICS PERFORMANCE EXPECTATION(s):

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

MPE.35: Construct and justify the constructions of congruent segments and angles, segment and angle bisectors, and parallel and perpendicular lines.

VII. CONTENT:

The issue of housing is an important concept to many students. In schools across the country students come from all walks of life. A student's life experience is what shapes them into a young adult. When students leave school some return to a home owned by their parents, some return to an apartment, and in some school environments a group home. Some students return to neighborhoods that are comprised of thriving communities that make them feel safe and secure. Some students return to neighborhoods where they are scared to come out because it is not safe. The purpose of this unit is to give students a chance to dream, to take the knowledge that they have

learned and apply it. This unit will give them the opportunity to explore and learn from people in a community who work in housing development and architecture. This will be accomplished by having the students research a variety of housing options and possibilities on the internet as well as having people who work in housing development and architecture come into the classroom and work with the students. With this information and the knowledge and skills related to constructions they will acquire, their finished product will be a model of their dream house.

VIII. REFERENCE/RESOURCE MATERIALS:

For each lesson of this unit, there will be activities with accompanying journal entries expected. The activities and their rubrics are all attached to this overview. Instructional technology used for this unit will be Geometer's Sketchpad (or similar dynamic software).

IX. PRIMARY ASSESSMENT STRATEGIES:

- Classroom activities
- Journal entries
- Quizzes
- Unit test
- Model

X. EVALUATION CRITERIA:

Scoring rubrics for all assessments are attached to this overview.

XI. INSTRUCTIONAL TIME:

9 90-minute blocks.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Lesson 1: Constructing Triangles and Quadrilaterals

Strand
Geometry

Mathematical Objective(s)
Students will construct a variety of triangles and quadrilaterals using a compass and straight edge.
Students will identify properties of quadrilaterals and triangles.
The specific math goal of this lesson is for students to apply their knowledge of basic constructions to constructing both triangles and quadrilaterals. Through a discovery activity, they will simultaneously realize the properties of the various types of triangles and quadrilaterals.

Mathematics Performance Expectation(s)
MPE.35: Construct and justify the constructions of congruent segments and angles, segment and angle bisectors, and parallel and perpendicular lines.

Related SOL:

G.4 (Constructions)

G.9 (Quadrilaterals)

Both of these will be addressed in Lessons 3 and 4, and are of equal priority for this lesson.

NCTM Standards
- Draw and construct representations of two- and three-dimensional geometric objects using a variety of tools;
- Analyze precision, accuracy, and approximate error in measurement situations;
- Apply and adapt a variety of appropriate strategies to solve problems.

Additional Objectives for Student Learning
None

Materials/Resources
- Class set of compasses and straight edges
- Printer paper
- Copy of activity

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Assumption of Prior Knowledge

Students should have a working knowledge of constructions. They should understand the tools used to make constructions (compass and straight edge). The student should understand and be able to construct the following: a segment congruent to a given segment, the perpendicular bisector to a point not on a given line, an angle bisector, and an angle congruent to a given angle.

The student should have a working knowledge of the properties of quadrilaterals and triangles. The student should be able to differentiate between the various types of quadrilaterals. For example, the student should know the difference between a parallelogram and rectangle both visually and by properties.

The student should be familiar with the different types of triangles. The student should be classified as a level three on the Van Hiele scale. This classification should be extended to constructions and properties of quadrilaterals and triangles. The student should be able to isolate and relate the properties of a quadrilateral.

As a result of this lesson, students might begin to better differentiate between the various quadrilaterals and triangles. Therefore, they will better express their ideas regarding how these polygons relate to each other. It is expected that they will use specific vocabulary to refer to names, parts, and characteristics of the polygons and realize the need for these exact and descriptive terms.

Students may have difficulties or misconceptions based on prior knowledge, or lack thereof, and/or using the tools required. Depending on how long it has been since the students have had Geometry, they may have forgotten the properties of these polygons. In everyday life, people often use terms to describe polygons that are inaccurate and if they have acquired these habits, then it will pose confusions for them. Some students may not have used a compass and straight edge, and may have difficulty adapting to using one in a short amount of time. A teacher knows his/her students, and can make adaptations or adjustments as necessary to meet these needs.

Under the Van Hiele scale, this lesson builds upon level two. When the Geometry course has been successfully completed, the student should be able to determine the differences between quadrilaterals. The student should be able to classify different types of triangles.

At the end of this lesson, the students will begin thinking about planning a home. There will be a discussion regarding the numerous housing situations where people live. This is relative to the social issue of housing, and the goal is to begin building an awareness of the various available housing for people in our society.

Introduction: Setting Up the Mathematical Task

- In this lesson, the students will investigate the properties of quadrilaterals and triangles. This will be accomplished using a compass and straight edge to construct the polygons, and investigating patterns, similarities, and differences.
- It is expected that this lesson will take 1.5 90 minute block periods (or three 45 minute periods). The time will be less if students have a good recollection of constructions and therefore do not need as much review in the beginning.
- A suggested introduction to this lesson should involve a warm-up activity that assesses the students' knowledge and recollection of constructions as well as parallel lines intersected by a transversal. This will be done giving them some problems using the basic constructions necessary for this lesson, along with some questions to be answered. An alternate introduction could be to have a discussion to assess students' current knowledge of constructions.
- Once the warm-up is complete, students will be given the activity sheet where they will begin to explore the properties by doing constructions. The activity sheet will have guided questions to direct their thinking towards the goals for the lesson, with additional questions at the end of the activity to both help summarize they have learned and have them begin looking ahead to the rest of the unit when they will begin working on their dream house.
- At the end of the activity, there will be a group discussion to be sure students understand the properties and constructions. The discussion will then be extended to encourage students to talk about their personal situations and experiences. The teacher will discuss some situations about which the students may not be aware. The teacher will also share with the students a PowerPoint displaying a variety of housing possibilities from a variety of cultures and socioeconomic levels. The purpose of having this whole group aspect is so that students broaden their exposures which will in turn give them more to think about as they begin to plan their own homes.
- Students will be asked to draw on their prior knowledge during the warm-up and throughout the lesson. The teacher will be available for help and/or guidance in understanding the task.
- Students will make their mathematical thinking and understanding public at the end of the lesson when there is the class discussion. During the class discussion, the teacher will ask guiding questions to assess learning and understanding of constructing quadrilaterals and triangles as well as their properties.

Student Exploration 1:

Student/Teacher Actions:

- Students will be working on the activity sheet where they will be expected to construct and investigate triangles and quadrilaterals.
- While students are working on the activity, the teacher should make himself/herself available to students that have questions. While some questions (especially technical ones related to the tools of construction) may be answered directly, the teacher should try to redirect the student's thinking so that the student is able to answer the question himself/herself. Again, a teacher knows their students and therefore will adapt this policy as needed for each individual.
- To facilitate learning, the teacher should ensure that all students are on task. Also, as the teacher circulates around the classroom, he/she should question the students beyond what is on the activity to make them think further, and understand.
- This particular lesson will introduce students to the paper and pencil approach to constructions, but in a later lesson they will use technology to do the same thing. This lesson could be adapted for cooperative/collaborative learning with students working together on the activity.

Monitoring Student Responses

- Expectations:
    - Students will communicate their thinking and new knowledge during the class discussion.
    - Students will answer questions and complete summary table in the activity. They will be using their constructions in order to answer these questions about triangles and quadrilaterals.
    - Teacher will circulate around the room to assist as needed, and will pair students (for the entire lesson) with differing levels of confidence.

- Summarizing the lesson:
    - Closure for the lesson will take place during the group discussion at the end of the activity. This will be the time for the information to be pulled together, for feedback to be given, the lesson reinforced, as well as opened for leading to upcoming lessons and the unit as a whole.
    - Some of the ways of collecting evidence of the students' knowledge of the described content will be from the activity sheet and journal entries.

Assessment

- Describe and attach the assessments for each lesson objective.
    - **Questions**
        - What characteristics are shared between a parallelogram and a rectangle?
        - What are some of the important concepts you have learned today?
    - **Journal/writing prompts**
        - What are the first words that come to mind when hearing the term 'affordable housing'?
        - Take a walk through your neighborhood, what are the things you notice? Shopping? Schools?
    - **Other**

      Using your camera, go out into your neighborhood and take pictures of the homes you see. List anything you notice about the way the home is structured. If you live in an area where apartment buildings are the primary living facility take pictures of the apartment buildings. For students that may not have access to a camera or camera phone, the internet or a magazine could be used as alternatives.

Extensions and Connections (for all students)

- For this lesson, there are no extensions, but there will be for later lessons in this unit.
- This lesson connects to Geometry.
- This lesson connects to drafting.

Strategies for Differentiation

- List ideas for addressing needs of a diverse population of students such as:
    - For auditory learners having trouble, there are videos available online with audio that explain step-by-step how to do the basic constructions. The lesson is already kinesthetic and visual, so those learners should not have problems.
    - For students that may have processing, memory, or motor issues, an adaptation could be to have them work with another student.
    - ELLs will be able to use a dictionary to translate terms they are not familiar with.
    - For high-ability students, students could be asked to construct the quadrilaterals without being given the parallel lines.

Lesson 2: Architectural Basics

Strand
Geometry

Mathematical Objective(s)
Students will have the opportunity to meet with a community architect.
Students will have the opportunity to meet with a city housing authority.

Mathematics Performance Expectation(s)
MPE.32: The student will use the relationships between angles formed by two lines cut by a transversal to

a) determine whether two lines are parallel;

b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and

c) solve real-world problems involving angles formed when parallel lines are cut by a transversal.

Related SOL:

G.4 (Constructions)

G.9 (Quadrilaterals)

EPF.11 (Economics and Personal Finance) the student will demonstrate knowledge of planning for living and leisure expenses.

Both of these will be addressed in Lessons 3, 4 and 5, and are of equal priority for this lesson.

NCTM Standards

- Recognize and use connections among mathematical ideas
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
- Recognize and apply mathematics in contexts outside of mathematics

Additional Objectives for Student Learning
None

Materials/Resources

- Class set of compasses and straight edges
- Printer paper
- Unit Journal

Assumption of Prior Knowledge

Students should have a working knowledge of geometry. Students should be a level two Van Hiele of basic geometry, specifically quadrilaterals, triangles, and angles. Students should be able to recognize (based on definitions and properties) right angles in pictures and/or diagrams. Students should be able to recognize and know the differences between various quadrilaterals both visually and by properties.

Introduction: Setting Up the Mathematical Task

- In this lesson, the students will have the opportunity to talk with an architect and a housing official. The architect will speak about the mechanics of making a blueprint and a model. The housing official will include in their presentation information about demographics and differences between multi-family and single-family housing.
- It is expected that this lesson will take two 90 minute block periods. The time will be less depending on the length of each speaker.
- The introduction to this lesson will involve a journal assignment in which students will answer 3 sets of questions based on their knowledge of architecture and housing.
- Once the pre-journal assignment is complete, students will be asked to develop 3-4 questions to ask each speaker. The questions should help the students develop their plan for building their house.
- At the end of the activity, there will be a group discussion to be sure students understand what was presented during the speakers' presentations. The purpose of having this whole group aspect is so students can be exposed to a variety of available housing options which will in turn give them more to think about as they begin to plan their own houses. The speakers will stay for the discussion to be available for any questions or clarifications that are requested.
- Once the speakers and discussions have been completed, the students will be asked to answer another set of questions in their journal. The hope is that students now have an understanding of where they should be headed in this unit.

Student Exploration 1:

- Students will be listening to the speaker to gain knowledge on how to develop a blueprint for their own house. The students will be listening to the speaker to gain knowledge about the various types of housing available.
- While students are working on the activity, the teacher should make himself/herself available to students that have questions. The teacher should keep the students on task and help focus their thoughts to meaningful questions.
- To facilitate learning, the teacher should ensure that all students are on task. Also, as the teacher circulates around the classroom, he/she should question the students beyond what is on the activity to make them think further, and understand.

Monitoring Student Responses

- Expectations:
    - Students will communicate their thinking and new knowledge during the class discussion.
    - Teacher will help direct students to stay on task. Teachers should guide the questioning session, so that students ask helpful questions.
- Summarizing the lesson:
    - Closure for the lesson will take place during the group discussion at the end of the activity. This will be the time for the information to be pulled together, as well as for students to ask any questions about what was spoken about.
    - Some of the ways of collecting evidence of the students' knowledge of the described content will be from the activity sheet and journal entries.

Assessment

- Describe and attach the assessments for each lesson objective.
    - Questions
        - Students will answer a set of questions before the guest speakers
        - Students will write 3 -4 questions to ask the guest speakers
        - Students will answer a set of questions once the speakers have finished.
    - Journal/writing prompts (Pre-guest speaker Journal)
    - Architecture Journal entry (pre)
        - Using your pictures from lesson 1, what do you notice about the structure of each home/ apartment building?
        - What do you notice about the angles of each home/ apartment building?
        - What do you notice about the sides of each home/ apartment building?
        - In general what similarities do you notice about these houses/ apartment buildings?

- Housing Official journal entry (pre)
    - Write a description of your dream home. Include the number of bedrooms, bathrooms, and other items.
    - Go online and research different types of housing available. This will help develop their research skills as they search for good sites to obtain this information. For example, students will find pictures and cost of homes and apartments for various socio-economic levels and bring those to class.
- Post-Journal Entry
    - What knowledge have you gained by talking with the architect?
    - What knowledge have you gained by talking with the housing official?
    - What have you learned about affordable housing?

Extensions and Connections (for all students)

- This lesson can be used with a drafting course. This lesson can be extended to include household budget. While the students are developing plans to build their house, they could also research what is involved in maintaining a home.

Strategies for Differentiation

- List ideas for addressing needs of a diverse population of students:
    - For students with kinesthetic, auditory, and/or visual learners the teacher can remind the speaker to bring in figures and handouts for the students to look at. The teacher should circulate around the room to help students stay on task.
    - For students with processing, memory, and/or motor issues the teacher should encourage the students to take notes or tape record the speaker. This will ensure the student has something to fall back on when completing the journal assignments. The teacher should ask each speaker to bring in handouts that the students can keep.
    - The teacher should remind English language learners (ELLs) to bring their translating dictionary in to help with words they do not understand.

Lesson 3 Dynamic Polygons

Strand
Geometry and Measurement

Mathematical Objective(s)
Students will construct a variety of triangles and quadrilaterals using the program Geometer's Sketchpad or any other similar dynamic geometric software.
Students will identify properties of quadrilaterals and triangles.
The specific math goal of this lesson is for students to transfer their knowledge from Lesson 1 of constructing both triangles and quadrilaterals to doing these same constructions using the software program. Through a discovery activity, they will generalize their prior knowledge. In lesson 1, they constructed one example of each polygon. In this activity they will construct one of each, but then will change the size of each, make observations, and then generalizations thus confirming the properties of these polygons.

Mathematics Performance Expectation(s)
MPE.4: The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems
MPE.35: Construct and justify the constructions of congruent segments and angles, segment and angle bisectors, and parallel and perpendicular lines.

Related SOL

G.4 (Constructions)

G.9 (Quadrilaterals)

Both of these have been addressed in Lessons 1, 3, and 4, and are of equal priority for this lesson.

NCTM Standards
- Apply appropriate techniques, tools, and formulas to determine measurements
- Apply and adapt a variety of appropriate strategies to solve problems
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- Draw and construct representations of two- and three-dimensional geometric objects using a variety of tools;
- Analyze precision, accuracy, and approximate error in measurement situations

Additional Objectives for Student Learning (include if relevant; may not be math-related):

None

Materials/Resources

- Classroom set of computers with Geometer's Sketchpad (GeoGebra or other similar programs can be used if GSP is not available)
- Activity worksheet

Assumption of Prior Knowledge

- Students should have a working knowledge of constructions. They should understand the basics of using the dynamic software.
- The student should understand and be able to use the following tools on the dynamic program they will be using: segment, circle, point, perpendicular lines, parallel lines, intersection point, and hide objects.
- The student should have a working knowledge of the properties of quadrilaterals and triangles.
- The student should be familiar with the different types of triangles. The student should be classified as a level three on the Van Hiele scale. This classification should be extended to constructions and properties of quadrilaterals and triangles. The student should be able to isolate and relate the properties of a quadrilateral.
- As a result of this lesson, students will begin to better differentiate between the various quadrilaterals and triangles. Therefore, they will better express their ideas regarding how these polygons relate to each other. It is expected that they will use specific vocabulary to refer to names, parts, and characteristics of the polygons and realize the need for these exact and descriptive terms.
- Students may have difficulties or misconceptions based on prior knowledge, or lack thereof, and/or using the tools required. Since they have recently completed Lesson 1, it is expected that they should have recent knowledge on the topics. However, the possibility for difficulties and misconceptions still exist. In everyday life, people often use terms to describe polygons that are inaccurate and if they have acquired these habits, then it will pose confusions for them. Some students may not have used Geometer's Sketchpad before, and may have difficulty adapting to using it in a short amount of time. A teacher knows his/her students, and can make adaptations or adjustments as necessary to meet these needs.
- Under the Van Hiele scale, this lesson builds upon level 2. When completing their Geometry course the student should be able to determine the differences between quadrilaterals. The student should be able to classify different types of triangles.
- At the end of this lesson, the students will continue thinking about planning a home. They will soon have the opportunity to apply all they have studied thus far to plan and construct a house of their choice.

Introduction: Setting Up the Mathematical Task

- In this lesson, students will use dynamic software to investigate the properties of triangles and quadrilaterals. This will be accomplished using Geometer's Sketchpad (or similar program) to construct the polygons, and investigating patterns, similarities, and differences.
- It is expected this lesson will take 1.5 90-minute block (or three 45-minute periods). This time will vary based on students' prior experiences using the software.
- The task will be introduced by using questions connecting back to Lesson 1. These questions should point to the fact that in that lesson, they constructed only one example of each polygon. Therefore, is it acceptable to generalize the properties based on those? If the answer is no (and it should be), then, what needs to happen in order to make a generalization? This is an opportunity to point out the role and importance of proof in mathematics. Furthermore, this is when the idea of testing conjectures without having to hand-construct many constructions will make things much less tedious but accomplish the goal at hand.
- With this introduction, the activity sheet will be distributed and the students will work independently on the activity. Teachers know their students, and can make adaptations where they feel necessary (for example, if a student would be more successful partnering with another student, or if enough computers are not available for each student to have one).
- By working through the activity sheet, students will be moving towards the stated goals and objectives. Their prior knowledge will be drawn upon through the questions presented throughout the activity.
- The teacher will help the students understand the task by circulating around the classroom during the activity and helping to guide instruction as well as answer technology questions. It is essential that the teacher be familiar with the technology in order to answer questions that may arise.
- At the end of the lesson, students will be invited to share their constructions with the class by projecting them with an LCD projector. They will then explain the conjectures they made and why they believe they are correct. The rest of the class will be polled to see if they agree with these conclusions. In this way, students will have the opportunity to make their mathematical thinking and understanding public.

Student Exploration 1:

Student/Teacher Actions:

- Students will be working on the activity sheet where they will be expected to construct and investigate triangles and quadrilaterals using dynamic software.
- While students are working on the activity, the teacher should make himself/herself available to students that have questions. While some questions (especially technical ones related to the software) may be answered directly, the teacher should try to redirect the student's thinking so that the student is able to answer the question himself/herself. Again, a teacher knows their students and therefore will adapt this policy as needed for each individual.
- To facilitate learning, the teacher should ensure that all students are on task. Also, as the teacher circulates around the classroom, he/she should question the students beyond what is on the activity to make them think further, and understand.
- This particular lesson integrates technology so students can verify the properties of triangles and quadrilaterals. This lesson could be adapted for cooperative/collaborative learning with students working together on the activity.

Monitoring Student Responses

- Expectations:
    - Students will communicate their thinking and their new knowledge by answering the questions on the activity sheet
    - Students will communicate with each other at the end of the lesson when they share their constructions;
    - Teacher will circulate around the room to assist as needed, and will pair students (for the entire lesson) with differing levels of confidence.
- Summarizing the lesson:
    - Closure for the lesson will take place during the group sharing at the end of the activity. This will be the time for the information to be pulled together, for feedback to be given, the lesson reinforced, as well as connecting all of the lessons so far in the unit in anticipation for the culminating activities in Lessons 4 and 5.
    - Some of the ways of collecting evidence of the students' knowledge of the described content will be from the activity sheet and journal entries.

- Describe and attach the assessments for each lesson objective.
    - **Questions**
        - What are some of the major concepts you have learned today?
        - Which do you prefer – compass and straight-edge constructions or using the dynamic software? Why?

- **Journal/writing prompts**
  - After today's lesson, what does the phrase "seeing is believing" mean to you? How does it relate to mathematics?
  - What are your thoughts now regarding affordable housing? How, if at all, have they changed since Lesson 1?

- Include descriptions of any necessary accommodations.
- For each assessment, include the evaluation criteria (i.e., describe and/or attach appropriate scoring rubrics, observation checklists, rating scales, item weights, and the like).

Extensions and Connections (for all students)

- For this lesson, there are no extensions, but there will be for later lessons in this unit.
- This lesson connects to Geometry.
- This lesson connects to drafting.

Strategies for Differentiation

- List ideas for addressing needs of a diverse population of students such as:
  - For auditory learners having trouble, pairing them with another style of learner who can explain the steps may be helpful. The lesson is already kinesthetic and visual, so those learners should not have problems.
  - For students that may have processing, memory, or motor issues, an adaptation could be to have them work with another student.
  - ELLs will be able to use a dictionary to translate terms they are not familiar with.
  - For high-ability students, students could be asked to construct the quadrilaterals without steps being given and then have the students explain how they know their quadrilateral is correct.

Lesson 4 Blueprint

Strand
Geometry

Mathematical Objective(s)
Students will be using knowledge of triangles, quadrilaterals, and dynamic software to create a blueprint for a house.

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

MPE.35: Construct and justify the constructions of congruent segments and angles, segment and angle bisectors, and parallel and perpendicular lines

Related SOL

- G.4 (Constructions)
- G.9 (Quadrilaterals)

NCTM Standards
- Use visualization, spatial reasoning, and geometric modeling to solve problems
- Build new math knowledge through problem solving.
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- Use the language of mathematics to express mathematical ideas precisely

Materials/Resources
- Work from previous lessons
- Sketching paper
- Computer with Geometer's Sketchpad (or other similar program)
- Printer
- Optional: straight-edge and/or compass

Assumption of Prior Knowledge
- At this point in the unit, students should have a very good understanding of the properties of triangles and quadrilaterals as well as using dynamic geometric software for constructing the aforementioned polygons.

- In order to be successful with this lesson, students should now be at a minimum Level 2 on Van Hiele, although the ideal would be Level 3.
- Students should now begin to make connections between the lessons we have done. After these lessons, they should be using specific terms for the polygons as well as vocabulary that was explained to them from the speakers.
- Students may have difficulty getting started because they will be thinking independently without a great deal of direction from the teacher.
- This lesson builds on the previous lessons in this unit and is part of a culminating activity for those lessons.
- This lesson will address the social issue of housing by having the students plan two houses. One house will be a "dream house" and one will be assigned to them based on a variety of housing options available to people.

Introduction: Setting Up the Mathematical Task

- In this lesson, you will plan and construct a blueprint for two homes. The first will be one that your group agrees on as a "dream" house. The second will be assigned to you by your teacher.
- This lesson will take 1.5 90-minute blocks. The half block will be for planning with your group and the full block will be the actual construction of the house using Geometer's Sketchpad or a similar dynamic software.
- Through prior journal entries, the students have begun to develop their ideas of a dream house as well as developing their knowledge base about housing issues. The students will be divided into groups of four to allow them to share ideas. During the first meeting, they will plan what their group's dream house is. Also during that time, the teacher will assign a house for them to plan. The teacher-assigned house will be chosen from a variety of housing options available to people. These could include: trailers, housing projects, apartments, and single family dwellings of all sizes. Students will make their new knowledge public at the completion of Lesson 5.

Student Exploration 1:

Small Group Work:

Students will work on this lesson in groups of four.

Student/Teacher Actions:

- During the first part of the lesson, students should be in their groups discussing their ideas of a dream home. They can make sketches, if they choose. Then, they should come to a consensus of a group dream home. Once they are given their assigned home, they are also

to come up with a plan for what that will look like. The next part of the lesson is constructing these two homes using Geometer's Sketchpad or a similar dynamic software. Throughout the entire lesson, students are to work in their groups while the teacher is available to answer questions and keep students focused and on-task.

- As the teacher circulates around the room and observes the plans being developed, questions may be required to help guide thinking. For example, "Should your bathroom be as large as the bedroom?" "Have you thought about where the kitchen will be?" "Should you have parallel walls?" "What type of quadrilateral should you be using for the foundation of your building?"
- Technology will be integrated by use of Geometer's Sketchpad in order to accomplish the objective.

Monitoring Student Responses

- Expectations:
    - Students will communicate their thinking within their groups, by their finished products, as well as in journal entries.
    - For students that are ready to move forward, one possible extension would be to have the students research costs associated with building a house in order to approximate the cost for building their houses. They will explore the internet and any other resources in order to find this information.
- Summary:
    - Once the blueprint is complete, the students will move into Lesson 5, which will then have closure.
    - Evidence of students' knowledge will be collected through observations, the blueprints, presentations in Lesson 5, and journal entries.

Assessment

- Describe and attach the assessments for each lesson objective.
    - **Journal/writing prompts**
        - Dream Home:
            1. What was the most difficult part of planning your "dream" house?
            2. How well did your group interact while planning?
            3. What concepts did you use from the guest architect to guide your planning?
        - Assigned Home:
            1. What was the most difficult part of planning your assigned home?
            2. How well did your group interact while planning?
            3. How useful was the information from the housing official? How did that information guide your planning?

Extensions and Connections (for all students)

- A lesson extension could be to have a discussion and research regarding costs of building a house.

Strategies for Differentiation

- By having students working in groups that are teacher-assigned, needs of the diverse population can be met in how the groups are assigned.

Lesson 5 Building a House

Strand
Geometry

Mathematical Objective(s)
Students will consider all they have learned in this unit (properties of triangles and quadrilaterals, using dynamic software to construct polygons, and information from the guest speakers) to choose the blueprint from Lesson 4 that they would like to build, and then build a model of that house.

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

MPE.35: The student will construct and justify the constructions of the basic constructions.

Related SOL's:

- G4: Quadrilaterals
- G9: Constructions

NCTM Standards
- Use visualization, spatial reasoning, and geometric modeling to solve problems.
- Solve problems that arise in mathematics and in other contexts.
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
- Use the language of mathematics to express mathematical ideas precisely.
- Recognize and apply mathematics in contexts outside of mathematics.

Materials/Resources
- Activity assignment and rubric
- Blueprints from Lesson 4

Assumption of Prior Knowledge
- At this point in the unit, students should have a very good understanding of the properties of triangles and quadrilaterals as well as using dynamic geometric software for constructing the aforementioned polygons.

- A typical student should be operating under Van Hiele Level 2 or 3 for polygons for this activity, because they should not only recognize and identify the polygons, but understand which ones would fit together to create the best home to meet their goals.
- Students should begin expressing what they have learned from the architect and housing official in order to help them choose which of their blueprints they would like to build.
- Students tend to not like having to make their own decisions, so having them work together to do this may be challenging at first for some. However, with good direction they should be able to get over this obstacle and complete the lesson.
- Prior to this lesson, students have learned the properties for triangles and quadrilaterals. They also should know how to construct figures using Geometer's Sketchpad.
- This activity requires them to consider the social issue of housing and develop a house based on newfound knowledge and information.

Introduction: Setting Up the Mathematical Task

- In this lesson, the group will decide which of the two blueprints will actually be built. A plan will then be developed and a blueprint model made.
- It is suggested that this activity will take 2-3 90 minute blocks.
- The task can be introduced to students by having them look at the blueprints they did for Unit 4 and decide as a group which house they will build. Since this is a continuation of Lesson 4, the task should not require a lengthy introduction, just a review of a few basics. Students will continue to work with their groups from Lesson 4, which will allow collaboration so they can achieve a more planned home than they could do individually. Building the house will move towards the stated objectives and goals because they will be putting the knowledge they have gleaned from this unit to work by having to apply them to a real world problem.
- At the end of the lesson, each group will present their completed home. This is how the students will be publicly communicating their new knowledge.

Student Exploration 1:

Small Group Work
Whole Class Sharing/Discussion
Student/Teacher Actions:

- At the beginning of this lesson, the students, in their groups, will come to consensus about which house they will build. Once that decision is made, they will need to develop a list of needed materials and a plan for the construction. Based on availability, teachers can provide some (or all) supplies. The next day (or two) in class will be devoted to the students

working on building the house. Students can work outside of class either as a group or independently (on parts of the model that will be put together upon return to class). Once the house is complete, they will then answer the questions and plan their presentation.

- While the students are working, the teacher should circulate around the classroom to help keep students focused and on task, as well as to answer questions.
- This activity does not include direct technology integration, but is based on the electronic blueprint developed in Lesson 4.

Monitoring Student Responses

- Expectations
    - Students will communicate their thinking and new knowledge amongst their groups throughout this lesson. They will also communicate this to the class by way of the presentation at the end of the lesson, and to the teacher with the answers to the questions related to the activity.
    - To extend the material for students that are ready to move forward, the house could be built to scale making use of similar figures and proportions. Another possible extension could be researching and approximating costs of building their house.
- Summarization
    - There is time built into the lesson for oral as well as written closure to the activity. At the end of the lesson, each group will present their final product and include specific information about their planning and outcome. In addition, students will submit answers to questions regarding their process, outcome, and learning.

Assessment

- **Journal/writing prompts**
    - Building the Home
        - What shapes did your group use when building your home?
        - What was the most challenging part of putting your blueprint to work?
        - How did you choose your materials? Why?
    - Reflection
        - What was the most difficult part of this assignment?
        - What changes would you make if you had to do assignment over?
        - What knowledge have you gained?

- **Other**
    - Finished house

- For students that may not have access to needed materials (i.e. financial issues), the teacher can try to gather materials by asking art teachers and other personnel on campus (depending on the needed supplies) to help. It is expected that teachers will have basic supplies such as scissors and glue available to students.

Extensions and Connections (for all students)

- As in Lesson 4, an extension could be for students to research and approximate building costs for their home. Another extension could be reviewing similarity and proportions and building a house that is proportional to an actual house that could be built (including measurements).
- This Lesson connects to drafting and architecture.

Strategies for Differentiation

- By having students working in groups that are teacher-assigned, needs of the diverse population can be met in how the groups are assigned.

Part 1: Exploring Triangles

Directions: Answer the following essential questions before completing the activity.

Triangles Essential Questions:

- What are polygons?
- What are three-sided polygons?
- What are the various types of triangles?

For this activity, you will be using a compass and straight edge for constructions. You will also use a protractor and metric ruler for measurements. For purposes of this activity, the following coding will be used to refer to the constructions:

CS: construct a segment congruent to a given one

CA: construct an angle congruent to a given one

PB: construct the perpendicular bisector of a segment

BA: bisect an angle

PO: construct the perpendicular to a line from a point not on the line

I. Construct an equilateral triangle (use CS).

a. Construct the perpendicular (PO) from one of the triangle's vertices to the opposite side.

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b. What have you now created? How do you know? What do you know about the sides of these triangles? What do you know about their angles? Based on that information, how could you best describe the new triangles?

II. Using the straight edge, sketch a scalene triangle. From one of the vertices, construct the median to the opposite side (use PB to find the midpoint).

a. Are the two new triangles congruent to each other? Why or why not? Describe each of the triangles by both sides and angles.

Summary: fill in the chart below to summarize the properties of the various triangles.

	3 congruent sides	2 congruent sides	No congruent sides
One right angle			
One obtuse angle			
3 acute angles			

Part 2: Exploring Quadrilaterals

Directions: Answer the following essential questions before completing the activity.

Quadrilaterals Essential Questions:

- What are four-sided polygons?
- What are parallel lines? What do they look like?
- What properties are shared among the various quadrilaterals? Compare/Contrast

I. Given two parallel lines, construct a parallelogram following the steps below.

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a. Choose a point on line *n* and label it A. Using your straight edge, draw a segment from point A to line *g*. Label the endpoint B. Segment AB will be the left side of your parallelogram, so be sure to leave space for the right side.

b. Label a point C on line *g*. Construct <C congruent to <B so that it opens to the right. Extend the new ray so that it intersects line *n*, and label that point D.

Exploring your construction:

1. How do you know your construction is a parallelogram?

2. What do you know about the sides? Be thorough and specific (including measures where necessary).

3. What do you know about the angles? Be thorough and specific (including measures where necessary).

II. Given two parallel lines, construct a rectangle following the steps below.

a. Choose a point A on line *n.* Construct the perpendicular from point A to line *g*. Label the intersection point B.

b. Now choose a point D also on line *n*. Construct the perpendicular form point D to line *g*. Label the intersection point C.

Exploring your construction:

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1. How do you know your construction is a rectangle?

2. What do you know about the sides? Be thorough and specific (including measures where necessary).

3. What do you know about the angles? Be thorough and specific (including measures where necessary).

III. Given two parallel lines, construct a rhombus following the steps below.

a. Using a straight edge, draw a segment from line *n* to line *g*. Label the endpoints A and B. This will be the left side of your rhombus so please leave space for the right side.

b. Use your compass to construct segment BC so that it is congruent to segment AB.

c. Use your compass to construct segment AD so that it is congruent to segment AB.

d. Using a straight edge, draw segment CD.

Exploring your construction:

1. How do you know your construction is a rhombus?

2. What do you know about the sides? Be thorough and specific (including measures where necessary).

3. What do you know about the angles? Be thorough and specific (including measures where necessary).

IV. Given two parallel lines, construct a square following the steps below.

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a. Choose point A on line *n* and construct a perpendicular from it to line *g*. Label the intersection point B.

b. Construct segment AD so that it is congruent to segment AB.

c. Construct the perpendicular from point D to line *g*. Label the intersection point C.

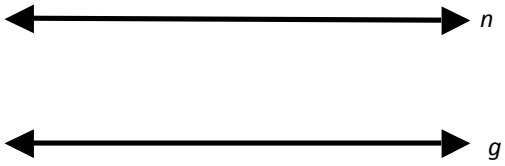
Exploring your construction:

1. How do you know your construction is a square?

2. What do you know about the sides? Be thorough and specific (including measures where necessary).

3. What do you know about the angles? Be thorough and specific (including measures where necessary).

V. Given two parallel lines, construct a trapezoid following the steps below.



a. Using a straight edge, draw two segments from line *n* to line *g*.

b. Label your trapezoid ABCD.

Exploring your construction:

1. How do you know your construction is a trapezoid?

2. What do you know about the sides? Be thorough and specific (including measures where necessary).

3. What do you know about the angles? Be thorough and specific (including measures where necessary).

Lesson 1 **Activity Sheet Answer Key**

Triangles and Quadrilaterals

Note: Answers are possible or suggested solutions, not necessarily the only answers.

Part 1: Exploring Triangles

Triangles Essential Questions:

- Closed figures that are three or more sides and comprised of segments that intersect each other only at their endpoints.
- Triangles
- Acute, obtuse, right, equilateral, scalene, isosceles, and equiangular.

For this activity, you will be using a compass and straight edge for constructions. You will also use a protractor and metric ruler for measurements. For purposes of this activity, the following coding will be used to refer to the constructions:

CS: construct a segment congruent to a given one

CA: construct an angle congruent to a given one

PB: construct the perpendicular bisector of a segment

BA: bisect an angle

PO: construct the perpendicular to a line from a point not on the line

I.

a. I have created two right triangles that are congruent. The triangles are 30-60-90 triangles because the perpendicular is also a bisector. The triangles are right scalene triangles, and they are congruent to each other.

II. Using the straight edge, sketch a scalene triangle. From one of the vertices, construct the median to the opposite side (use PB to find the midpoint).

a. The two new triangles are not congruent. They have two pairs of congruent sides (the shared side and the one bisected), but no known congruent angles. One of the triangles is obtuse scalene and the other is acute (or right) scalene.

Summary: fill in the chart below to summarize the properties of the various triangles.

	3 congruent sides	2 congruent sides	No congruent sides
One right angle	Not possible	Right isosceles	Right scalene

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One obtuse angle	Not possible	Obtuse isosceles	Obtuse scalene
3 acute angles	Equilateral equiangular	Acute isosceles	Acute scalene

Part 2: Exploring Quadrilaterals

Quadrilaterals Essential Questions:

- Quadrilaterals.
- Parallel lines are lines that are coplanar and do not intersect. They have the same slopes, and look like the two l's in the word parallel.
- Shared properties:
  Opposite sides congruent – parallelogram, rectangle, rhombus, square
  Opposite angles congruent – parallelogram, rectangle, rhombus, square
  Opposite sides parallel – parallelogram, rectangle, rhombus, square
  4 right angles – rectangle, square
  4 congruent sides – rhombus, square
  Diagonals bisect each other – parallelogram, rectangle, rhombus, square
  Diagonals are congruent – rectangle, square
  Diagonals bisect opposite angles – rhombus, square

I. Exploring your construction:

1. Opposite sides are parallel because corresponding angles are congruent.
2. Opposite sides are congruent.
3. Opposite angles are congruent. Consecutive angles are supplementary.

II. Exploring your construction:

1. It is a parallelogram with 1 right angle.
2. Opposite sides are congruent.
3. 4 right angles.

III. Exploring your construction:

1. It is a parallelogram with four congruent sides.
2. The sides are congruent.

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3. Opposite angles are congruent and consecutive angles are supplementary.

IV. Exploring your construction:

1. It is a rectangle and rhombus (4 right angles and 4 congruent sides).
2. The sides are congruent.
3. Four right angles.

V. Exploring your construction:

1. It has 4 sides and has one pair of parallel sides.
2. The sides are all different (or two are the same – the legs).
3. There are two pairs of consecutive angles. If the legs are congruent, then there are two pairs of congruent angles.

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Lesson 1

Grading Rubric

(Points earned is based on the amount of points the student achieves out of the possible points. The degree of accuracy required is a teacher decision, which will be based on their knowledge and expectations of their students.)

Part 1: Triangle Exploration (40 points)

Category	Possible Points	Points Earned
1. *Construction lines can be seen for all of your constructions*	10	
2. *Each triangle was constructed correctly*	10	
3. *Student made accurate and supported observation of each triangle constructed*	10	
4. *Student correctly completed summary chart*	5	
5. *Essential Questions*	5	

Total Points earned for part 1 _____

Part 2: Quadrilateral Explorations (60 points)

Category	Possible Points	Points Earned
1. *Construction lines can be seen for all of your constructions*	15	
2. *Each quadrilateral was constructed correctly*	15	
3. *Student accurately answered the exploring questions*	10	
4. *Student correctly completed summary chart*	10	
5. *Essential Questions*	10	

Total points earned for part 2_____

Total Score _____

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Lesson 2 (see Lesson Plan for questions)

Rubric

Journal notes: when grading the journal please remember to not grade the entries that are personal reflection.

- Architecture Journal entry (pre)
  - Using your pictures from lesson 1, what do you notice about the structure of each home/ apartment building?
  - What do you notice about the angles of each home/ apartment building?
  - What do you notice about the sides of each home/ apartment building?
  - In general what similarities do you notice about these houses/ apartment buildings?
- Housing Official journal entry (pre)
  - Write a description of your dream home. Include the number of bedrooms, bathrooms, and other items. (*not graded for content*)
  - Go on line and research different types of housing available. For example, bring pictures and cost of homes and apartments for various socio-economic levels.
- Post-Journal Entry
  - What knowledge have you gained by talking with the architect?
  - What knowledge have you gained by talking with the housing official?
  - What changes have you made to the plans for your home?

Pre and Post- Journal Entries - Maximum amount of points earned on journals 27 points

Completion of Entries	**Pre Journal (Architecture)**	**Pre Journal (Housing) question #2**	**Questions for speakers**	**Post Journal**	**Post Journal**
0 points for 0 -1 entries	0 points for no conjectures made	0 points for no information	0 points for no questions	0 points for 0 entries	0 points no new conjectures
1-2 points for 2- 3 entries completed	1 -2 points for some conjectures and connections	1 -2 points for pictures of homes	1 -2 points for 1 question	1 – 2 points for 1 entry	1 -2 for some conjectures
2 – 3 points for 4 entries completed	2 -3 points for making connections	2 – 3 points for pictures of various homes	2 -3 for 2 questions	2 - 3 points for 2 entries	2 -3 for conjectures
3 – 4 points for 5 entries completed	3 - 4 points for making some connections with geometry	3 – 4 points for variety of pictures and cost	3 – 4 for 3 questions	3 - 4 points for 3 entries	
4 -5 points for 6 entries	4 -5 points for making connections with geometry	4 -5 points for completing assignment correctly	4 - 5 points for 4 questions		

Triangles and Quadrilaterals

In this activity, you will be using Geometer's Sketchpad (a software program) to explore triangles and quadrilaterals. (If you are using a different dynamic software, you will need to adapt these directions.) Please save each construction using your name_polygon name (example: Nelson_parallelogram). You can save the triangles as one file. These should be submitted along with the answers to the questions below.

Part 1: Exploring Triangles

Directions:

Open Geometer's Sketchpad.

Using the segment tool, construct a segment AB. Next, using the circle tool, construct a circle with the center on A and a radius endpoint at B. Construct another circle with the center on B and a radius endpoint at A. Choose the point tool, and place a point at the intersection of the two circles above the segment. Label this point C. Construct segments AC and BC. Go to the pointer tool, highlight the two circles (ONLY) and go to Display>Hide Circles.

1. What do you know about the triangle you have constructed? Why do you think this is the case?
2. Test your conjecture from #1 by finding the measure of each of the sides and each of the angles. To do that, using the pointer tool, highlight segment AB (ONLY) and go to Measure>Length. Do this again for each of the two other sides of the triangle. Then, using the pointer tool make sure nothing is highlighted and click on A, then B, then C and go to Measure>Angle. Repeat this for the other two angles. Was your conjecture correct?
3. Test to see if changing the size of the triangle will change your results. Click on one vertex of your triangle and drag it around. What happens to the measurements? Try doing this with a different vertex? What happens?

Now, construct the perpendicular from one of the triangle's vertices to the opposite side. That is accomplished by using the pointer tool to click on one vertex, and then the side across from that vertex. Choose Construct>Perpendicular line. Construct a segment (using segment tool) on top of the line from the vertex to where it intersects the opposite side. Then hide the line (keeping only the segment visible).

1. What has been created? How do you know?
2. What do you know about the sides of these triangles? What do you know about their angles?
3. Based on that information, how could you best describe the new triangles?

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REMINDER: To test your conjectures, be sure to measure the new segments and angles you have created and then drag the figure by different vertices to see what happens.

Using the segment tool, construct a scalene triangle. To be sure it is scalene, measure each segment. Make changes to your segments if necessary. From one of the vertices, construct the median to the opposite side by highlighting the side and going to Construct>Midpoint. Then, construct the segment from the vertex to the midpoint.

1. Are the two new triangles congruent to each other? Why or why not? Find the measures of all sides and angles in order to confirm your conjecture.
2. Describe each of the triangles by both sides and angles.

Summary (review): fill in the chart below to summarize the properties of the various triangles.

	3 congruent sides	2 congruent sides	No congruent sides
One right angle			
One obtuse angle			
3 acute angles			

Part 2: Exploring Quadrilaterals (using Sketchpad or other dynamic software)

Parallelogram:

Using Sketchpad, construct a segment and a point above the segment. Then, construct a segment parallel to the first segment by highlighting the point and the segment and then choosing Construct>Parallel Line. Construct a segment that connects the original point to the closest endpoint of the original segment. Now, highlight this new segment, and the other endpoint of the original segment and Construct>Parallel Line. Last, construct the segments that make this parallelogram and then hide the lines.

Exploring your construction:

1. How do you know your construction is a parallelogram?

2. What do you know about the sides? Be thorough and specific (including measures).

3. What do you know about the angles? Be thorough and specific (including measure).

4. Find the slopes of the sides of the parallelogram by clicking on each segment, one at a time, and then choosing Measure>Slope. What do you notice about the slopes? Is this a surprise? Why or why not?

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Rectangles

Using Sketchpad, construct a segment AB. Next, using the pointer tool, click on A and then segment AB and choose Construct>Perpendicular Line. Click on B and segment AB and choose Construct>Perpendicular Line. On the line perpendicular to the segment through point A, construct a point and label it D. Click on D and segment AD and choose Construct>Perpendicular Line. Using the vertices A, B, C (where the new line intersects the perpendicular to the segment through point B), and D, construct the segments that are sides of the rectangle. Then hide the lines.

Exploring your construction:

1. How do you know your construction is a rectangle?

2. What do you know about the sides? Be thorough and specific (including measures).

3. What do you know about the angles? Be thorough and specific (including measures).

4. Find the slopes of the sides of the rectangle by clicking on each segment, one at a time, and then choosing Measure>Slope. What do you notice about the slopes? Is this a surprise? Why or why not?

Rhombus:

Using Sketchpad, construct a segment AB. Using the circle tool, construct a circle with center A and radius AB. Construct a point on the circle above the segment and label it point D. Construct segment AD. Using the circle tool, construct a circle with D as the center and radius DA. Also construct a circle with center B and radius AB. Construct a point at the intersection point of these two circles (point C). Construct segments BC and CD. Highlight the circles and hide them.

Exploring your construction:

1. How do you know your construction is a rhombus?

2. What do you know about the sides? Be thorough and specific (including measures).

3. What do you know about the angles? Be thorough and specific (including measures).

4. Find the slopes of the sides of the rhombus by clicking on each segment, one at a time, and then choosing Measure>Slope. What do you notice about the slopes? Is this a surprise? Why or why not?

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Square:

Using Sketchpad, construct segment AB. Click on A and segment AB and choose Construct>Perpendicular Line. Using the circle tool, construct a circle with center A and radius AB. At the point where the circle and perpendicular line intersect, construct point D. Construct segment AD. Construct a circle with center D and radius AD, and another circle with center at B and radius AB. Where these two circles intersect, construct point C. Construct segments BC and CD. Highlight the line and circles and hide them.

Exploring your construction:

1. How do you know your construction is a square?

2. What do you know about the sides? Be thorough and specific (including measures).

3. What do you know about the angles? Be thorough and specific (including measures).

4. Find the slopes of the sides of the square by clicking on each segment, one at a time, and then choosing Measure>Slope. What do you notice about the slopes? Is this a surprise? Why or why not?

Trapezoid:

Using Sketchpad, construct trapezoid ABCD. Before starting, plan out your construction based on what you know about the properties and the tools you have available in the software.

Exploring your construction:

1. How do you know your construction is a trapezoid?

2. What do you know about the sides? Be thorough and specific (including measures).

3. What do you know about the angles? Be thorough and specific (including measures).

Lesson 3 **Activity Sheet Answer Key**

Triangles and Quadrilaterals

Part 1: Exploring Triangles

Directions:

1. It is an equilateral triangle because the sides are congruent since they are each a radius of congruent circles.
2. Yes.
3. The measurements change, but are still congruent to each other.

Now, construct the perpendicular from one of the triangle's vertices to the opposite side. That is accomplished by using the pointer tool to click on one vertex, and then the side across from that vertex. Choose Construct>Perpendicular line. Construct a segment (using segment tool) on top of the line from the vertex to where it intersects the opposite side. Then hide the line (keeping only the segment visible).

1. Two right triangles have been created.
2. The sides of the triangles are not congruent. The angles are 30-60-90.
3. The two new triangles are congruent right scale triangles.

Using the segment tool, construct a scalene triangle. To be sure it is scalene, measure each segment. Make changes to your segments if necessary. From one of the vertices, construct the median to the opposite side by highlighting the side and going to Construct>Midpoint. Then, construct the segment from the vertex to the midpoint.

1. The two new triangles are not congruent to each other. There are two pairs of corresponding congruent sides, but no other information is known.
2. One triangle is acute scalene (or right scalene) and the other is obtuse scalene.

Summary (review): fill in the chart below to summarize the properties of the various triangles.

	3 congruent sides	2 congruent sides	No congruent sides
One right angle	Not possible	Right isosceles	Right scalene
One obtuse angle	Not possible	Obtuse isosceles	Obtuse scalene
3 acute angles	Equiangular equilateral	Acute isosceles	Acute scalene

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Part 2: Exploring Quadrilaterals (using Sketchpad or other dynamic software)

Parallelogram:

Exploring your construction:

1. Both pairs of opposite sides are parallel.
2. Opposite sides are parallel and congruent.
3. Opposite angles are congruent and consecutive angles are supplementary.
4. The slopes of the opposite sides are congruent. This is the case because parallel lines have the same slope.

Rectangles

Exploring your construction:

1. It is a parallelogram with four right angles.
2. Opposite sides are congruent and parallel.
3. Four right angles.
4. Opposite sides have the same slopes. Consecutive sides have slopes that are negative reciprocals of each other. Parallel lines have the same slopes and perpendicular lines have slopes whose product is -1.

Rhombus:

Exploring your construction:

1. It is a parallelogram with four congruent sides.
2. Four congruent sides.
3. Opposite angles are congruent and consecutive angles are supplementary.
4. Opposite sides have the same slope, which means they are parallel.

Square:

Exploring your construction:

1. It is a rectangle and rhombus.
2. It has four congruent sides.
3. Four right angles.
4. Opposite sides have the same slopes, and consecutive sides have slopes that are negative reciprocals of each other. Parallel lines have the same slope, and perpendicular lines have slopes whose product is -1.

Trapezoid:

Exploring your construction:

1. It is a quadrilateral with one pair of congruent sides.
2. None of the sides are congruent. If the student constructed an isosceles trapezoid, then two sides will be congruent.
3. There are two pairs of supplementary angles. If the student has constructed an isosceles trapezoid, then there will also be two pairs of congruent angles.

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Lesson 3

Grading Rubric

Part 1: Triangle Exploration (40 points)

Category	Possible Points	Points Earned
1. *Construction lines and circles can be seen for all of your constructions*	10	
2. *Each triangle was constructed correctly*	10	
3. *Student answered questions correctly.*	5	
4. *Students used appropriate methods to test and explain conjectures.*	10	
5. *Students correctly completed the summary chart.*	5	

Total Points earned for part 1 _____

Part 2: Quadrilateral Explorations (60 points)

Category	Possible Points	Points Earned
1. *Construction lines can be seen for all of your constructions*	15	
2. *Each quadrilateral was constructed correctly*	15	
3. *Student accurately answered the exploring questions*	10	
4. *Student used appropriate methods to test and explain conjectures.*	10	
5. *Student correctly completed summary chart*	10	

Total points earned for part 2_____

Total Score _____

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Lesson 4

Blueprint Activity

Group member names:

Directions: When your two blueprint assignments have been completed, please turn in the following:

1. A printout of both blueprints
2. Email the teacher an electronic copy of both blueprints
3. Answer the questions below, turn in one response per group.
4. When your blueprints have been approved pick one design to build.

PLEASE REMEMBER YOU ARE BEING GRADED ON A RUBRIC, SO BE AS THOROUGH AND CREATIVE AS POSSIBLE!

Questions

A. Dream Home:
    1. List the polygons that were used to make your blueprint.
    2. Did you construct any parallel lines to make your blueprint?
    3. What polygon is most often used in the construction of your polygon?
    4. What mathematical connections were needed to complete your blueprint?

B. Assigned Home:
    1. List the polygons that were used to make your blueprint.
    2. Did you construct any parallel lines to make your blueprint?
    3. What type of angles where used primarily in your blueprint?
    4. What mathematical connections were needed to complete your blueprint?
    5. If your assigned home was an apartment in a building what mathematical changes were needed?
    6. If your assignment home was a single family dwelling, did you notice anything different in the blueprint from your “dream” home blueprint?

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Lesson 4

Blue print Rubric

Questions

A. Dream Home:

1. List the polygons that were used to make your blueprint.
2. Did you construct any parallel lines to make your blueprint?
3. What type of angles where used primarily in your blueprint?
4. What mathematical connections were needed to complete your blueprint?

B. Assigned Home:

1. List the polygons that were used to make your blueprint.
2. Did you construct any parallel lines to make your blueprint?
3. What type of angles where used primarily in your blueprint?
4. What mathematical connections were needed to complete your blueprint?
5. If your assigned home was an apartment in a building what mathematical changes were needed?
6. If your assignment home was a single family dwelling, did you notice anything different in the blueprint from your "dream" home blueprint?

Math Assessment	**Construction design**	**Use of Technology**		**Completion of Questions**	**Math Terminology**
0 points no math shown in blueprint	0 points for no constructions	0 points for poor use of technology		0 points for no response	0 points no use of math terms
1 -2 points for the use of some mathematics	1 -2 points for basic constructions	1 -2 points for limited use of technology		1 – 2 points for some response	1 -2 for limited use of math terms
2 -3 points for limited math	2 – 3 points for limited and basic constructions with errors	2 -3 for correctly using technology		2 - 3 points for making some mathematical connections	2 -3 for limited use of math terms correctly
3 - 4 points for few mathematical errors	3 – 4 points for correct use and design of constructions with few errors	3 – 4 for enhanced use of technology		3 - 4 points for making mathematical connections with error	3 – 4 for use of math terms correctly
4 -5 points for strong mathematics	4 -5 points correct use and design of constructions			4 -5 points for strong mathematical connections	4 -5 for use of higher level math terms

Maximum points earned for blueprint design 14 points

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Maximum points earned for Questions 10 points

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Lesson 4

Journal Rubric

A. Dream Home:
    1. What was the most difficult part of planning your "dream" house?
    2. How well did your group interact while planning?
    3. What concepts did you use from the guest architect to guide your planning?

B. Assigned Home:
    1. What was the most difficult part of planning your assigned home?
    2. How well did your group interact while planning?
    3. How useful was the information from the housing official? How did that information guide your planning?

Journal Entries

Completion of Entries	**Dream Home (A)**	**Assigned Home (B)**
0 points for 0 -1 entries	0 points for no response made	0 points for no information
1-2 points for 2- 3 entries completed	1 -2 points for 1 or 2 insightful replies	1 -2 points for 1 or 2 insightful replies
2 – 3 points for 4 entries completed	2 -3 points for some insightful and detailed replies	2 – 3 points for some insightful and detailed replies
3 – 4 points for 5 entries completed	3 - 4 points for some detailed and making mathematical connections	3 – 4 points for some detailed and making mathematical connections
4 -5 points for 6 entries	4 -5 points for making mathematical detailed connections	4 -5 points for making mathematical detailed connections

Maximum amount of points earned on journals 15 points

Lesson 5

Building a House

Group member Names:

Directions: your group will pick one blueprint to build. You may use any materials to build your home. Each group will present their home to the class. During your presentation you will include the following:

1. A list of materials
2. Your reasons for picking the home to build
3. Discuss how the guest architect directed your decisions for building
4. Discuss the effect the housing official had on your group
5. Each presentation should be 15 minutes.

When your group presents please give this sheet to the teacher for scoring.

Topic	Maximum Points	Points Earned
Material List	10	
Quality of home	30	
Discussion of building your home	15	
Discussion of housing official	15	
Participation of Group members	15	
Presentation Time	15	

Total Points_____

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Lesson 5

Journal Rubric

Students pick either topic A or B to answer depending on which house they have chosen to build. All students should complete topic C.

A. Building your "dream home"
    1. What mathematical approach did your group use when building?
    2. What was the most challenging part of putting your blueprint to work?
    3. How did you choose your materials? Why?

B. Building your assigned home:
    1. What mathematical approach did your group use when building?
    2. What was the most challenging part of putting your blueprint to work?
    3. How did you choose your materials? Why?

C. Reflection:
    1. What was the most difficult part of this assignment?
    2. What changes would you make if you had to do the assignment over?
    3. What knowledge have you gained on the following?
        a. Housing as a socio-economic issue
        b. Construction of housing
        c. Design of housing
        d. Cost of design/construction of housing

Journal Entries (Maximum amount of points earned on journals 14 points)

Completion of Entries	**Dream Home (A)**	**Assigned Home (B)**	**Reflection (C)**
0 points for 0 - 2 entries	0 points for no response made	0 points for no response	0 points for no response
1-2 points for 3 - 4 entries completed	1 -2 points for 1 or 2 insightful replies	1 -2 points for 1 or 2 insightful replies	1 -2 points for responding
2 – 3 points for 4-5 entries completed	2 -3 points for some insightful and detailed replies	2 – 3 points for some insightful and detailed replies	2 – 3 points for detailed responses
3 – 4 points for 6-8 entries completed	3 - 4 points for some detailed and making mathematical connections	3 – 4 points for some detailed and making mathematical connections	3 – 4 points for detailed and through responses
4 -5 points for 9 entries	4 -5 points for making mathematical	4 -5 points for making mathematical	

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	detailed connections	detailed connections	

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