Building Your Own Home

I. UNIT OVERVIEW & PURPOSE:
This unit will focus on helping students understand what they need to know about building a house and what math is involved in the process.

II. UNIT AUTHOR:
Abby Smith, Paul Reese, & Matthew Browning

III. COURSE:
Mathematical Modeling: Capstone Course

IV. CONTENT STRAND:
Geometry

V. OBJECTIVES:
Students will apply their knowledge of surface and volume to a real-world problem.
Students will discriminate the difference from two-dimensional figures and three dimensional figures through drawing house plans.

VI. MATHEMATICS PERFORMANCE EXPECTATION(s):
MPE.3a The student will use pictorial representations, including computer software, constructions, and coordinate methods to solve problems involving symmetry and transformations. This will include investigating and using formulas for finding distance, midpoint, and slope.
MPE.6 The student will use formulas from surface area and volume of three dimensional objects to solve real-world problems.

VII. CONTENT:
Students will get a taste of what it takes to build a new home from the ground up. They will get exposure to pouring footers and concrete pads by calculating volume; they will learn how the pitch of a roof corresponds to slope, they will learn how drywall and shingles relate to surface area, they will learn how water piping and HVAC relates to volume, etc.

VIII. REFERENCE/RESOURCE MATERIALS:
Students will be given multiple reading assignments to assist them in the background knowledge necessary to carry out the task of building a home.

IX. PRIMARY ASSESSMENT STRATEGIES:
There will be both daily assessments and a cumulative evaluation.

X. EVALUATION CRITERIA:
At the end of each assessment there will be a copy of a rubric that is appropriately aligned with the assessment.

XI. INSTRUCTIONAL TIME:
5 – 7 90 minute blocks

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1 Laying the Foundation

Strand
Geometry

Mathematical Objective(s)
In the past students have been given shapes and dimensions and then been asked to find either the surface area or volume. The goal of this lesson is for students to have an opportunity to see when those ideas are used in the real-world. In this case students will use volume to calculate the amount of concrete needed to build a foundation of a home.

Mathematics Performance Expectation(s)
MPE.6 The student will use formulas from surface area and volume of three dimensional objects to solve real-world problems.

Related SOL:

G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

NCTM Standards

- analyze properties and determine attributes of two- and three-dimensional objects

Materials/Resources
- Classroom set of graphing calculators
- Excel spreadsheet
- Articles related to building a foundation for background knowledge (See attached websites below)
    - http://www.newhomesource.com/resourcecenter/articles/solid-foundation
    - http://home.howstuffworks.com/home-improvement/repair/house4.htm/printable
    - http://www.wikihow.com/Pour-a-Concrete-Foundation
- At least one laptop or tablet per group for research
- "Laying the Foundation Worksheet" (See attached worksheet)

Assumption of Prior Knowledge
- Students should be familiar with formulas used for volume and surface area.
- Students should be able to distinguish the difference between a 2-D and 3-D figure.
- Students should be able to manipulate volume and surface area formulas to fit objects that are not typically found in textbooks.
- Students might find it simple to figure out the volume of concrete they need for the floor/slab, but many struggle calculating the amount of concrete needed for the walls of the basement.

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- Students can draw on experiences they have had with estimating materials for projects, planning a building or actually working on a construction site.

Introduction: Setting Up the Mathematical Task

- Before the first day of the lesson students will be given at least two articles about laying a foundation of a house to read as a homework assignment.
- Students would be asked to read the articles and create 5 – 10 questions regarding laying the foundation.
- Before breaking students up into groups, the instructor could draw on students' prior knowledge by asking if any of the students have ever seen a house being built. Ask if any of the students wanted to one day build their own home.
- When the students come to class on Day 1 of this lesson they would either choose their group members or be assigned a group. In their groups they would discuss their thoughts about the articles and raise any of their questions. During their time together they can also research some of their questions on their laptop or tablet. If the students still have some basic questions, it can be addressed by the instructor. In fact, it might be worthwhile to have a concrete professional or an engineer in class on the first day (if possible)
- Students will have the choice to build a home in one of three scenarios:
    - Urban (House would be between 600 – 1,000 square feet footprint)
    - Suburban (House would be between 1,000 – 2,500 square feet footprint)
    - Rural (House would be 2,500 square feet or larger footprint)
- The instructor should remind students that the square footage deals with total living space and not simply the foundation. They could create a very tall house with minimal ground floor surface area or the house could be all on one level.
- The instructor now needs to explain the goals for the day:
    - Students need to decide under which type of scenario they would want to build.
    - Students need to decide whether they want a single-level or multi-level house. With that in mind, students need to decide if they want a basement or if they simply want to build their house on a slab.
    - Students need to calculate the amount of concrete they will need to either pour a slab, a basement, or a combination of the two if they don't want a full basement.
- By the end of class students will have successfully calculated the amount of concrete they will need to pour the foundation of their new home. They will be asked to turn in their findings to the instructor.

Student Exploration:

Small Group Work

- In groups students should be discussing what scenario they will choose.
- Next, students need to decide if they want a full basement, partial basement, or slab.
- The group needs to decide what percentage of their house they want on the first floor. This will help them determine the dimensions of the basement or slab.

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- Students need to draw (to scale and including dimensions) a sketch of an above view of the foundation and a side view.
- Once they have decided these things, they can start working through the "Laying the Foundation" Worksheet.
- In conclusion, students can reflect upon their thoughts about the foundation (see assessment for more details)

Teacher responsibilities during this time:

- Instructors should monitor student progress by posing questions that would address any misunderstanding.
- The instructor can ask students how surface area and volume relate to each other in pouring a foundation to their home.
- If students are having a hard time figuring out what it takes to lay the foundation they can take up to 15 minutes to explore the following sites:
  - http://www.concretenetwork.com/concrete/howmuch/calculator.htm
  - http://www.cemexusa.com/ProductsServices/BlockCalculator.aspx
  - http://www.boral.com.au/bricks/how_many_bricks_blocks.asp

Monitoring Student Responses

- Students should communicate their thinking cooperatively with others in their group by working together to solve the problem at hand.
- Students should participate in group discussions using the vocabulary found in the articles. Have students record any new vocabulary words in their math journal.
- Teacher should appropriately scaffold groups who are struggling to understand both the general idea of the project and the mathematics involved.
- As groups finish the lesson, instruct students to write on the board two things they learned during the lesson. Lead a classroom discussion based off of what the students wrote on the board.
- As a whole group ask students what they mainly used today, surface area or volume? Have them explain their reasoning.
- Near the end of class students will post their drawing to the board. This will allow for other students to look at what other students did. The teacher could then pose the question, "if you could do this activity over would you change anything about your foundation based on what you saw others do?"

Assessment

- **Journal/writing prompts – It is assumed that students have a math journal to respond to the last bullet.**
  - Students should turn in the last sheet of the "Laying the Foundation Worksheet" (see attached)
  - Students should draw (to scale) an above view and a side view of their foundation plan
  - Students should write a minimum of two paragraphs to the following journal prompt:

- **Laying the Foundation -** Explain what steps your group took to calculate the amount of concrete needed. Why did your groups reasoning behind the scenario you choose?

- Each student is expected to turn in the worksheet and drawings. Some groups may go into more detail than others with regards to the final reflection paragraphs. Considerations may be taken for ELL students or SWD.
- A rubric is attached to track student achievement

Extensions and Connections (for all students)

- Students can review calculating the perimeter of different polygons.
- Ask students to calculate the length of the boards needed to construct the form for the concrete pad.
- If students are having a difficult time understanding the difference between volume and surface area, then the instruction can draw upon the comparison of a coke can. The liquid inside is volume, while the metal is the surface area.

Strategies for Differentiation

- Give each student in the group a specific assignment
- Do not allow the group to turn in the assignment until everyone signs the worksheet stating that they understand how the numbers came to be.
- If some students finish quicker than others, they can begin to sketch what they want the rest of the house to look like.
- If the class has a significant amount of ESL or ELL students, have the class summarize the websites in bullet point format before breaking into groups. Include translation if needed.
    - Students need to understand that this is a work in progress. They need to keep track of all of their materials and cost sheets.
    - It might be a good idea to remind students that in the end they will be required to turn in a cost sheet outlining the total cost of construction.

Laying the Foundation

As you learned in your reading, a quality house starts with a firm foundation. The foundation laid will determine the structural soundness of the house. You will begin today by deciding if you want a slab foundation or a basement.

Before you begin working on your house, read and discuss the following with your group members. The articles can be found at:

http://www.dexknows.com/local/home_improvement/guides_and_videos/materials-building-basement-6219/

Slab Foundation Option:

Step 1) Draw the outline of your house. Include any interior walls you wish to build. Be sure to include dimensions on your drawing. Label the angles.

Step 2) On your outline, draw where the footings will be located. The footing is located under the house walls and is 2 feet wide and 1 foot thick.

Step 3) Calculate the volume of the footing. Remember to break the footing into shapes you are familiar with (such as rectangular prisms). Use your volume formulas to calculate the amount of concrete needed for the footing. Include this number in your materials list.

Step 4) Before laying the cement flooring, sand is poured and leveled. This helps the house settle without causing damage to the house. Calculate the total area of the foundation using inches. Multiply the area by 4 in to calculate the volume of sand needed. Include this number in your materials list.

Step 5) Use the total area of the basement floor to calculate the amount of concrete needed. The concrete floor must be 3 ½ in thick. Include this number in your materials list.

Step 6) Put in your orders. Note that concrete is ordered in cubic yards. You might have to convert if you measured in feet and/or inches. You should know that 1 foot equals 12 inches, and 1 yard equals 3 feet. Remember, the term “cubic yards” is a measure of volume.

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Basement Option:

Step 1) Draw the outline of your basement. Include any interior walls you wish to build. Be sure to include dimensions on your drawing. Label the angles.

Step 2) Determine how deep to excavate: Include the height of the ceilings (between 8 and 10 ft) and an additional 7 ½ inches for the flooring.

Step 3) On your outline, draw where the footings will be located. The footing is located under the basement walls and is 2 feet wide and 1 foot thick.

Step 4) Calculate the volume of the footing. Remember to break the footing into shapes you are familiar with (such as rectangular prisms). Use your volume formulas to calculate the amount of concrete needed for the footing. Include this number in your materials list

Step 5) Use the height of the basement ceiling and your outline of the basement to determine the volume of concrete needed to pour into molds to build the walls. Include this number in your materials list. Use the following information to determine the thickness of the basement walls:

8 ft ceilings – 8 in walls

> 8 ft ceilings – 10 in walls

Planned Brick Veneer – 10 in walls

(Do you plan on having brick walls for the outside of your house?)

Step 6) Before laying the cement flooring, 4 inches of sand is poured and leveled. This helps the house settle without causing damage to the house. Use the area of the basement floor and the height of the sand to calculate the total amount of sand needed. Include this number in your materials list.

Step 7) Use the total area of the basement floor to calculate the amount of concrete needed. The concrete floor must be 3 ½ in thick. Include this number in your materials list.

Step 8) Put in your orders. Note that concrete is ordered in cubic yards. For any conversions remember that 1 foot equals 12 inches, and 1 yard equals 3 feet. Remember, the term “cubic yards” is a measure of volume. Further, sand is ordered in tons. “Tons” is a measure of weight, so this number will change depending on the type of sand chosen. On average, there is 0.05 tons in each cubic foot. Use this number to calculate the tonnage of sand needed.

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Materials List	Amount

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Foundation Order Form	
Building Materials	**Amount**
Concrete (cubic yards)	
Sand (tons)	

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Grading Rubric – Laying the Foundation

Group:_____

	4	3	2	1
Diagrams	Students' diagram is to scale with accurate measurements. Diagram has walls and footing clearly labeled with measurements. Diagram shows how students divided the area when determining volumes.	Students' diagram is to scale with mostly accurate measurements. Diagram has walls and footing clearly labeled. Diagram gives indication how the area was divided when determining volumes	Students' diagram uses straight lines with some measurements labeled. Diagram shows where walls and footing should be. Little work is shown for dividing the area when determining volumes.	Student's diagram is sloppy with little to no labels or measurements. Diagram does not or poorly indicates wall and footing placement. Work is not shown for dividing the area when determining volumes.
Calculating Volume	Students' work accurately demonstrates how to find volume and area of irregular figures. Answers are labeled and work is easy to follow.	Students' work demonstrates how to find volume and area of irregular figures. Minor mistakes may be made (such as rounding). Answers are labeled.	Students' work demonstrates an understanding of volume and area formulas. Mistakes in measurement may be made.	Students' work shows little to no understanding of calculating volume and area. Mistakes are made throughout the work.
Accurate Ordering	Students kept an accurate account of the materials needed for the project. Units are always labeled. On the order form, materials are requested in correct cubic yards.	Students kept an account of materials needed with the occasional minor mistake (rounding, arithmetic error). Units are usually labeled. On the order form, materials are requested in correct cubic yards	Students kept track of materials, occasionally forgetting to include certain materials. Units are occasionally labeled. Orders are made in cubic yards with some mistakes in conversions	Little to no records are available for the materials needed. Units are rarely or never labeled. On the order form, it is unclear what units are requested.

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2 Blueprint

Strand
Geometry

Mathematical Objective(s)
In the past students have been given shapes and dimensions and then been asked to find either the surface area or volume. The goal of this lesson is for students to have an opportunity to see when those ideas are used in the real-world. In this case students will use perimeter and area formulas to create a basic blueprint of their house.

Mathematics Performance Expectation(s)
MPE.6 The student will use formulas from surface area and volume of three dimensional objects to solve real-world problems.

Related SOL:

G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

NCTM Standards

- analyze properties and determine attributes of two- and three-dimensional objects

Materials/Resources
- Classroom set of graphing calculators
- Graph/Draft Paper
- Rulers
- At least one laptop or tablet per group for research
- Helpful website: http://www.ehow.com/how_5233136_draw-own-house-plan.html#page=5
- Blue-Print Website: http://www.smartdraw.com/specials/floorplans.asp?id=355175&gclid=CIqV0ZycwbUCFULf4AodmVAALQ
- "Blueprint Worksheet" (See attached worksheet)

Assumption of Prior Knowledge
- Students should be familiar with formulas used for perimeter, volume and surface area.
- Students should be able to distinguish the difference between a 2-D and 3-D figure.
- Students should be able to manipulate surface area formulas to fit objects that are not typically found in textbooks.

- Students will be drawing the house plans by hand first and then using computer software to see their work come to life. The software is very easy to use because it helps the students keep everything in perspective. However, on paper they will have to come up with a scale factor.
- Students can draw on experiences they have had with estimating materials for projects, planning a building or actually working on a construction site.

Introduction: Setting Up the Mathematical Task

- Before sketching their own house plans each student will be asked to take 5 – 10 minutes to close their eyes and imagine their dream house. Have students take out their journal and label the entry "My Dream Home". Ask students to journal about their ideal home and share their thoughts with their group members.
- To really get their minds thinking about house plans the students can explore some different options by looking through the following website on their laptops or tablets: http://www.thehousedesigners.com/
- Students should have chosen to build a home in one of three scenarios:
    - Urban (House would be between 600 – 1,000 square feet footprint)
    - Suburban (House would be between 1,000 – 2,500 square feet footprint)
    - Rural (House would be 2,500 square feet or larger footprint)
- With their groups the students should look at their current foundation and decide what they want their house to look like. For example, do they want a ranch home? Would you prefer a more contemporary style. Where do you want the rooms? Ect… They can simply jot down some notes before actually drawing.
- Before the students begin to draw they should read the following article to keep scale factor fresh in their minds: http://www.ehow.com/way_5569456_standards-drawing-house-plans.html
- Before breaking students up into groups for the main task, the instructor could draw on students' prior knowledge by asking if any of the students have ever seen a house plans before.
- The instructor now needs to explain the goals for the day:
    - Students will decide what kind of house they would like to build.
    - Students need to explain what types of rooms will be on each floor of the house.
    - Students will sketch a drawing of each floor of the house to scale and will include the dimensions of each room on the drawing.
    - Students will take their idea to the computer to use free software to draw the blueprint and then look at the model in 3-D so that they can see what the house will look like. (links listed on worksheet)
- By the end of class (or beginning of next class) students will have successfully drawn their house plans on draft paper and online. They will be asked to turn in their findings to the instructor.

Student Exploration:

Small Group Work

- In groups students should be discussing what general type of house plan they want to build.
- (Students will be given a worksheet to help them determine what will be on each floor of the house. Where will the bedrooms, kitchen, bathroom, etc. be located?)
- Next, students need to draw their floor plans by hand on graph paper. Their drawings should be to scale and students should include dimensions in each room of the house.
- Once the students have drawn their plans by hand they should bring their plans and worksheet to the instructor for final approval.
- If the instructor approves the work, then the students may use laptops/computers to draw their house with the software mentioned above.
- At the end of the lesson, students should turn in their worksheet, sketch, and computer print out to the instructor (a rubric is attached for scoring proposes)

Teacher responsibilities during this time:

- Instructors should monitor student progress by posing clarifying questions.
- The instructor can ask students how they determined their scale factor.
- Ask students why the dimensions are important? (flooring and furniture are possible responses)
- If students are struggling with decisions they can look at other floor plans online to get ideas.

Monitoring Student Responses

- Students should communicate their thinking cooperatively with others in their group by working together to create one floor plan.
- Teacher should encourage students to communicate with each other using the vocabulary found in the articles. Have students record any new vocabulary words in their math journal.
- Teacher should appropriately scaffold groups who are struggling to understand both the general idea of the project and the mathematics.
- As a whole group ask students what they mainly used today, perimeter, surface area or volume? Have them explain their reasoning.
- Near the end of class students will post their print-outs to the board. This will allow for other students to look at what other students did. The teacher could ask the students if any of them plan on using any of the house plans for their future house.

Assessment

- **Journal/writing prompts**
  - Students should turn in their journal “My dream home”
  - Students should turn in the worksheet helping them organize their thoughts about the floor plan.
  - Students should draw (to scale) an above view of each level of the house.

    - Students should print out their blueprints they created online.
- Each student is expected to turn in the worksheet and drawings. Some groups may go into more detail than others with regards to the final reflection paragraphs. Considerations may be taken for ELL students or SWD.
- A rubric is attached

Extensions and Connections (for all students)

- The instructor can remind students that the area of the room is the carpet or tile and the perimeter of the room is the trim.
- If students finish before others than they could use the floor dimensions to determine what type of flooring that would put in each room. They could even use the website to look up different types of flooring to decide what is cost effective.

Strategies for Differentiation

- If students are struggling with the computer software, demonstrate some of the basic using a projector connected to the teacher laptop/computer. Encourage students to simply explore the software before beginning their blueprint.
- Give each student in the group a specific assignment.
- Allow struggling groups to base their blueprint off of a plan found on The House Designers website.
- Do not allow the group to turn the assignment in until everyone signs the worksheet stating that they understand how the numbers came to be.
- Students need to understand that this is a work in progress. They need to keep track of all of their materials and cost sheets.
- It might be a good idea to remind students that in the end they will be required to turn in a cost sheet outlining the total cost of construction.

Blueprint Worksheet

A detailed blueprint is the master plan of the interior of you home. This is a picture drawn to scale of the bird's eye view into each level of the house. On the blueprint, you will be able to see the size of the bedrooms, how many closets are available, to where the kitchen sink is located! Before we get started, please make sure you have visited the following websites:

- http://www.ehow.com/how_5233136_draw-own-house-plan.html#page=5
– This website will give you a brief overview of the blueprint's job when building a home.

- http://www.thehousedesigners.com/
- This website will show you professional blueprints. Use the plans found on this site to help you get started when you are ready to draw you plan.

- http://www.smartdraw.com/specials/floorplans.asp?id=355175&gclid=CIqV0ZycwbUCFULf4AodmVAALQ
- You will need to download the Smartdraw software to draw your blueprint on the computer.

Step 1: Look through the ehow.com and thehousedesigners.com websites. Notice that several details of the house are shown on the blueprint.

Step 2: Decide with your group how many stories you home will have. You will need to create a blueprint for each level. Remember, if you built a basement from our lesson before, you will need to have a blueprint for this level as well.

Step 3: Decide what you'll want in your home: Indicate how many of each of these rooms you would like in your home. You do not need each specific room in your house.

Bedroom	Nursery
Bathroom	Mud Room
Powder Room	Entry
Kitchen	Recreation Room
Living Room	Deck
Den	Garage
Dining Room	Office

Other:

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Step 4: Decide where these rooms should go. If you have a one-story home, this step is easy, each room is on the first level! If you have multiple stories, consider where each room should be located. For example: I would want my kitchen and dining room to go on the first floor. I want the office and the recreation room to be downstairs in the basement.

Step 5: Scale Factor! We will not draw the actual size of the home. This means we'll need to decide on a scale factor to use for our drawings. For example, I might decide every 1 cm represents ½ foot. This can be written as 1 cm = ½ ft. Please put the scale on the bottom of every blueprint you draw.

Scale Factor for the blue print: _____

Step 6: Draw your blueprint.

- Remember the footprint you used when laying the foundation. Begin by drawing this to scale on the graph paper. This will be your outline for each level of your home.
- Work as a group to decide on the size of the rooms and placement. Ensure that there is no overlapping or missing area in your blueprint.
- Keep in mind the functionality of the home.
    - Which rooms should be beside each other?
    - Would you prefer defined rooms or an open concept?
    - Where would closets be needed?
    - What types of doors are needed?
    - Where should windows be placed?
- Please key items in the room to indicate the layout of the room. Example: In the bedroom draw a bed that would be appropriate for the space. In the kitchen draw in the countertops and refrigerator. In the dining room indicate where the table should go.
- Include the actual dimensions of each room along with a label for each room.

Step 7: Take your hand drawn blueprint to the teacher for approval. Make any alterations needed.

Teacher Recommendations:

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Step 8: Use the Smartdraw software to create an electronic blueprint. Print out and turn in your final blueprint, hand-drawn blueprint, and any additional notes you used along the way.

Step 9: Flooring. You and your group members need to decide the type of flooring you want in each room. Calculate the area of floor space that will be covered by each type of flooring. For more information on how to measure the area of the floor, go to the website http://www.ehow.com/how_4465304_measure-floor-square-feet.html .

Flooring Type (hardwood, tile, carpet, ect)	Total amount needed

Step 10: Turn in your work. You should turn in 1) The hand-drawn blueprint 2) The computer-created blueprint 3) Any notes/work made along the way 4) Flooring Type and Amounts.

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Grading Rubric – Blueprint

Group:_____

	4	3	2	1
Blueprint – Hand-Drawn	The blueprint created by hand uses carefully constructed perpendicular, parallel, and other lines. Rooms are labeled. Items are included to define the space.	The blueprint created by hand shows perpendicular, parallel, and other lines. Rooms are labeled. Items are included to define the space.	The blueprint created by hand uses some parallel and perpendicular lines; however, mistakes have been drawn. Most rooms are labeled. Some items are included to define the space.	The blueprint created by hand is drawn sloppily with many mistakes drawn. Rooms are rarely labeled. Rarely are items are included to define the space.
Blueprint – Computer	The computer created blueprint accurately depicts the hand drawn blue print. Students utilized the many aspects of the software and have created a detailed plan.	The computer created blueprint accurately depicts the hand drawn blue print most of the time. Slight alterations may have been made. Students utilized the aspects of the software and have created a detailed plan.	The computer created blueprint generally depicts the hand drawn blue print. Alterations have been made. Students sometimes utilized the aspects of the software and have created a general plan.	The computer created blueprint differs greatly form the hand drawn blue print. Students rarely utilized the aspects of the software and have created a general plan.
Measurements & Scale Factor	Student's blueprints are the same size as the foot print used in the previous lesson. Rooms are accurately drawn within the parameters. The measurements coincide with the scale factor. The scale factor is included on every document. Flooring area is correctly calculated.	Student's blueprints are the same size as the foot print used in the previous lesson. Rooms are accurately drawn within the parameters with an occasional mistake. The measurements coincide with the scale factor with little error. The scale factor is included on every document. Flooring area is calculated with few mistakes.	Student's blueprints are close to the same size as the foot print used in the previous lesson. Rooms fall outside the parameters or overlap at times. The dimensions are often mislabeled and coincide with the scale factor with some error. The scale factor is included on most documents. Flooring area is calculated with multiple mistakes.	Student's blueprints do not correlate to the foot print used in the previous lesson. Rooms fall outside the parameters or overlap often. The dimensions are mislabeled. The scale factor is rarely included on documents. Flooring area is not calculated or done so with little care.

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3 Perfect Pitch

Strand
Geometry

Mathematical Objective(s)
In the past students have been given shapes and dimensions and then been asked to find either the surface area or volume. The goal of this lesson is for students to have an opportunity to see when those ideas are used in the real-world. In this case students will use surface area formulas to figure out how many square feet of material they will need to cover their roof.

Mathematics Performance Expectation(s)
MPE.6 The student will use formulas from surface area and volume of three dimensional objects to solve real-world problems.

Related SOL:

G.3a The student will use pictorial representations, including computer software, constructions, and coordinate methods to … investigating and using formulas for … slope.

G.7 The student will solve practical problems involving right triangles by using the Pythagorean Theorem, properties of special right triangles, and right triangle trigonometry. Solutions will be expressed in radical form or as decimal approximations.

G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

NCTM Standards

- analyze properties and determine attributes of two- and three-dimensional objects

Materials/Resources
- Classroom set of graphing calculators
- Graph Paper
- Rulers
- At least one laptop or tablet per group for research
- Helpful website: http://roofgenius.com/roofpitch.htm
- "Perfect Pitch Worksheet" (See attached worksheet)

Assumption of Prior Knowledge
- Students should be familiar with formulas used to find surface area.
- Students should be familiar with the use of the Pythagorean Theorem.
- Students should be able to distinguish the difference between a 2-D and 3-D figure.
- Students should be able to manipulate surface area formulas to fit objects that are not typically found in textbooks.

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Mr. Michael Bolling, Virginia Department of Education

- Student might find it simple to calculate the pitch of the roof and the amount of shingles needed to cover the roof. However, they may struggle when figuring out how the amount of shingles changes when you change the pitch of the roof. The Pythagorean Theorem can be useful here.
- Students can draw on experiences they have had with estimating materials for projects, planning a building or actually working on a construction site.

Introduction: Setting Up the Mathematical Task

- Have students take a few moments to reflect through writing about slope. Ask students to write down what they remember about slope. Ask them to include at least two real-world examples of when we would use slope. Allow students to share their responses in either small group or whole group settings.
- If necessary remind students what slope is and how we find it.
- Explain to the students that the pitch of a roof is the same as the slope of the roof. Ask them why they think roofs have slopes. What are some drawbacks of a flat roof? A steep roof?
- Before breaking students up into groups, the instructor could draw on students' prior knowledge by asking if any of the students have ever helped put shingles on a roof or at least walked on a roof before.
- The instructor now needs to explain the goals for the day:
    - What sort of material they will cover their roof with to keep their house dry (metal, shingles, terracotta etc.)
    - Students will explore different options of roof plans.
    - Students will calculate the amount of material needed for at least 4 different types of roof plans. They will also discuss pros and cons for each type of roof plan.
- By the end of class, students will have successfully calculated the amount of material needed to keep their home dry. They will be asked to turn in their findings to the instructor.

Student Exploration:

Small Group Work

- In groups students will use their laptops to research the different types of roofs: http://www.ehow.com/info_8507172_basic-roof-trusses.html.
- They can also research what it take to make a roof truss: http://www.ehow.com/list_7389664_types-wooden-roof-trusses.html
- Once students have a basic understanding of what a roofline looks like and what it takes to build it they can start drawing their own.
    - Students can use this site to get an understanding of how we measure the steepness of a roof: http://roofgenius.com/roofpitch.htm
    - Students should create and draw 4 different types of roof lines. After each drawing they need to identify at least 2 pros and cons of each idea.
    - Students should also include the surface area of each type of roofline and a brief explanation regarding how they calculated the area.
    - After the students have thoroughly explored various types of rooflines they can decide which one best fits their home.

- Students can open the blueprint file from yesterday on their computers and add a roof line to their house, then print out their newest drawing.
- Pull the students back together as a group and ask them to reflect on how they chose the type of roof for their house.

Teacher responsibilities during this time:

- Instructors should monitor student progress by posing clarifying questions.
- The instructor can ask students why is it important to know about surface area when you are building a roof.
  - If students are having a hard time visualizing the pitch of a roof draw a coordinate plan on top of their roof sketch and have them calculate slope the old-fashioned way.

Monitoring Student Responses

- Students should communicate their thinking cooperatively with others in their group by working together to create one blueprint.
- Teacher should encourage students to communicate with each other using the vocabulary found in the articles. Have students record new vocabulary in their math journal.
- Teacher should appropriately scaffold groups who are struggling to understand both the general idea of the project and the mathematics.
- As a whole group ask students what they mainly used today, surface area or volume? Have them explain their reasoning.
- Students will share their reflections in a whole group setting.

Assessment

- **Journal/writing prompts**
  - Students should turn in their sketches of 4 different types of roof lines with at least 2 pros and cons of each idea.
  - Students should calculate the surface area of each type of roofline and a include brief explanation regarding how they calculated the area. Students should also explain how the surface area changed (if at all) based upon the pitch or slope.
  - Students should print out the latest view of their house with a roof on top.
- Each student is expected to turn in their conclusions and drawings. Some groups may go into more detail than others with regards to the final reflection paragraphs. Considerations may be taken for ELL students or SWD.
- A rubric is attached

Extensions and Connections (for all students)

- If students are having a hard time visualizing the pitch of a roof they can draw a coordinate plan on top of their roof sketch and calculate the slope the old-fashioned way.
- If students need an additional challenge, explain that roofing contractors price of materials sold on the square. A square is a 10 foot by 10 foot square with a surface area of 100 square feet. Have students calculate the materials needed in terms of squares.
- If students finish early, ask the group to discuss why homes in the north would have steeper roofs than those in the south.

Strategies for Differentiation

- Give each student in the group a specific assignment.
- Do not allow the group to turn the assignment in until everyone signs the worksheet stating that they understand how the numbers came to be.
- If some students finish quicker than others, they can begin calculate the cost of their new roof.
- Students need to understand that this is a work in progress. They need to keep track of all of their materials and cost sheets.
- It might be a good idea to remind students that in the end they will be required to turn in a cost sheet outlining the total cost of construction.

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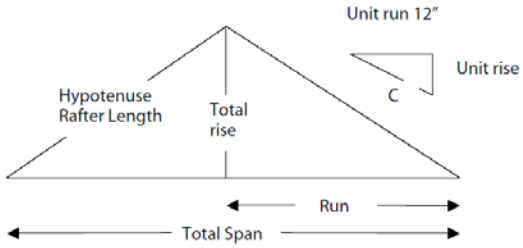
Perfect Pitch Worksheet



Roof pitch or roof slope is a measure of roof steepness or incline, represented in inches rise of 12 inches run. For example a "3 pitch" or "3 in 12 pitch" or "3/12 pitch" all imply that the roof rises 3 inches for every 12 inches of its horizontal run….(rise/run)

Common roof pitches are 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12. Less than 3 means the roof is practically flat, and higher than 12 means the roof would be too steep.

Choose four different roof pitches, and describe the slope of each. Then calculate the area of each in order to determine how much roofing is required. Decide on what material will be used to cover the roof (metal, shingles, terracotta, slate). Research the cost for your material and complete the cost worksheet.

Number of individual slates/shingles

Roof pitch → Type of roof ↓				
Metal				
Shingle				
Terra Cotta				
Slate				

Corresponding costs

Roof pitch → Type of roof ↓				
Metal				
Shingle				
Terra Cotta				
Slate				

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Grading Rubric – Perfect Pitch

Group:_____

	4	3	2	1
Journals	Students have diagrams and words describing different types of roofs. Students include multiple positive and negative reasons a person would choose the roof type. It is clear that students researched the topic in greater depth on their own. Students clearly state why they came to their final conclusion on roof pitch/type.	Students have diagrams and words describing different types of roofs. Students include some positive and negative reasons a person would choose the roof type. Students clearly state why they came to their final conclusion on roof pitch/type.	Students have diagrams or words describing different types of roofs. Students include some positive and negative reasons a person would choose the roof type. Students state why they came to their final conclusion on roof pitch/type.	Students have diagrams or words describing different types of roofs. Students rarely include positive and negative reasons a person would choose the roof type. Students do not state why they came to their final conclusion on roof pitch/type.
Blueprint Addition	Students added the roof to the blueprint with accuracy.	Students added the roof to the blueprint with few mistakes.	Students added the roof to the blueprint with multiple mistakes.	Students did not add the roof to the blueprint.
Calculation	Students used an accurate diagram and words to assist when calculating area. Work is clear drawing on previous knowledge. The surface area is correctly calculated.	Students used an accurate diagram to assist when calculating area. Work draws upon previous knowledge. Minor mistakes are made when calculating surface area.	Students used a diagram with some error to assist when calculating area. Work is not easy to follow. Some mistakes are made when calculating surface area.	Students did not use diagrams to calculate the area. Work is not easy to follow. Mistakes are often made when calculating surface area.

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4 Flow

Strand
Geometry

Mathematical Objective(s)
In the past students have been given shapes and dimensions and then been asked to find either the surface area or volume. The goal of this lesson is for students to have an opportunity to see when those ideas are used in the real-world. In this case students will use volume formulas to determine how much air is needed to heat and cool their home. They will also use volume formulas to explore water flow in pipes in and out of their home.

Mathematics Performance Expectation(s)
MPE.6 The student will use formulas from surface area and volume of three dimensional objects to solve real-world problems.

Related SOL:

G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

NCTM Standards List all applicable NCTM standards related to each lesson. Example:

- analyze properties and determine attributes of two- and three-dimensional objects

Materials/Resources
Describe the materials and resources (including instructional technology) you plan to use in each lesson.

- Classroom set of graphing calculators
- Graph Paper
- Rulers
- At least one laptop or tablet per group for research
- "Need to know about HVAC" Article
- "Flow Worksheet" (see attached worksheet)

Assumption of Prior Knowledge

- Students should be familiar with formulas used to calculate surface area and volume.
- Students should be able to distinguish the difference between a 2-D and 3-D figure.
- Students should be able to manipulate surface area formulas to fit objects that are not typically found in textbooks.
- Students might find it simple to calculate the area of the roof and the exterior walls in order to figure out how much heating/cooling is needed. However, they might find it difficult to calculate the volume of water pipes.

Introduction: Setting Up the Mathematical Task

- Ask students if they have ever felt too hot or too cold while at school. Ask them if the temperature has changed from room to room. After they throw out some responses, ask them why the temperature might be different.
- Have the students walk around the room and explore what is causing either heat loss or heat gain in the classroom (examples such as lights, computers, walls, ceiling, cracks, doors, window, etc).
- Present formulas to students in order to determine the amount of heat and coolant needed.
- This lesson might be harder for students to connect with, so it might be helpful to start off with an intro video before breaking students into groups. http://www.youtube.com/watch?v=R9rh5kCsEAk
- Hand out the "Need to know HVAC" article for students to keep track of new terms.
- The instructor now needs to explain the goals for the day:
    - Students will be able to calculate the amount of heat and coolant needed in their new homes by calculating the area of the roof and the area of the exterior walls.
    - Students will be able to calculate the volume of water needed for their home to be functional.

Student Exploration:

Small Group Work

- Students will open their latest version of their house plans on their laptop. They will then use the dimensions of each room to calculate the volume of each room.
- Once students know the volume of each room, they will be able to use the formulas provided so that they can calculate the amount of heat and coolant needed.
- Students will need to turn in a worksheet explaining how they calculated the amount of heat and coolant needed.
- Once students have finished the HVAC calculations they need to transition to water flow.
    - Students can assume they will be installing a PEX piping system. They can get an introduction by watching a short clip: http://www.youtube.com/watch?v=UeZSZAmG8FE
    - The students can decide where to install the distributor system either in the basement or in the crawl space under the house.
    - Anywhere there is a sink, shower, or washer a hot line and cold line needs to be run. Anywhere there is a toilet only a cold line needs to be run.
    - Students should sketch on their original drawing what the piping will look like running through their house. (Use a red-colored pencil for hot and a blue-colored pencil for cold)
    - Students need to calculate the amount of PEX piping needed in their home. (For purposes of this activity, students can assume that all of the piping will be installed in straight lines and meet at 90° angles.)
    - Students also need to calculate the amount of water needed to charge or fill all of their 1/2" PEX piping.

- In conclusion, pull the students back together as a group and ask them to share what they learned about heating and cooling. Also, ask them to share what they learned about the volume or piping. Was the amount of water needed to charge the lines more or less than expected?

Teacher responsibilities during this time:

- Instructors should monitor student progress by posing clarifying questions.
- The instructor can ask students why is it important to know about surface area when you are calculating the amount of heating and coolant needed.
  - Students have studied the measurements of the roof in the last lesson, so the main discussion points should be finding the area of the exterior walls.
  - The instructor should also assist any students who are struggling to calculate the amount of linear feet needed of PEX piping. The instructor could hint at the fact that all they need to calculate is the length since the diameter of the piping remains the same. The length is associated with the area of the walls and overall size of the house. In addition, if the house has multiple levels, the students must also calculate the distance from level to level.

Monitoring Student Responses

- Students should communicate their thinking cooperatively with others in their group by working together on the Flow worksheet.
- Teacher should encourage students to communicate with each other using the vocabulary found in the articles and videos. Have students record any new vocabulary learned in their journal.
- Teacher should appropriately scaffold groups who are struggling to understand both the general idea of the project and the mathematics.
- Ask students to share what they learned about heating and cooling. Also, ask them to share what they learned about the volume or piping. Was the amount of water needed to charge the lines more or less than expected?

Assessment

- **Journal/writing prompts**
  - Students should turn in their sketches of what the piping will look like winding through their homes.
  - Students should turn in the Flow Worksheet completed appropriately.
- Each student is expected to turn in their conclusions and drawings. Some groups may go into more detail than others with regards to the final reflection paragraphs. Considerations may be taken for ELL students or SWD.
- 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)

- Students have only calculated the heat transfer due to the roof and walls. Ask students what other calculations they could have taken into account. Also, students measured the volume of the water supply lines for their homes. What water lines did we not take into account?

Strategies for Differentiation

- Give each student in the group a specific assignment.
- Do not allow the group to turn the assignment in until everyone signs the worksheet stating that they understand how the numbers came to be.
- If some students finish quicker than others, they can look through the following document to calculate all of the heat transfer in the house including ceilings, doors, and windows: http://www.cedengineering.com/upload/Cooling%20Load%20Calculations%20and%20Principles.pdf

- Students need to understand that this is a work in progress. They need to keep track of all of their materials and cost sheets.
- It might be a good idea to remind students that in the end they will be required to turn in a cost sheet outlining the total cost of construction.

HVAC Need-to-Knows

Load calculation: Building load calculations consider a variety of issues: location (Boston's weather is different than that of Los Angeles), orientation (southwest glass gets much more sun than north glass), construction materials (R-value of insulation, brick or siding, etc.), building size, etc. Heating and cooling needs are expressed in British Thermal Units per hour or Btu/h. A "block load" looks at the whole building's requirements as one large room. A "room-by-room" load calculation refines the calculation to determine individual room's or zone's requirements.

Ton (of air conditioning): A "ton" of air conditioning refers to capacity in relation to melting one ton of ice in 24 hours. The capacity is measured in British Thermal Units (Btu); 288,000 Btu are required to melt one ton of ice in 24-hours (or 12,000 Btu/hr). A 2-ton air conditioner has a nominal capacity of about 24,000 Btu/h.

Manufacturer's performance data: This is information provided by the manufacturer to specify the capacity for a particular model. You may hear cooling terms like 2-ton or 3.5-ton. These are nominal capacities at standard rating points. For heating systems, the Btu/h are expressed by how much heating capacity goes into the furnace (i.e., an 80% efficient, 80,000 Btu/h furnace receives enough fuel to create 64,000 Btu/h of output heat).

Equipment selection: Equipment is manufactured to meet standardized performance requirements. Manufacturers publish expanded performance data that details how the equipment performs at actual operating conditions. Applying the manufacturer's performance data to your home's load is essential to saving energy with the right unit.

Efficiency: Performance descriptors for cooling are Seasonal Energy Efficiency Ratio (SEER) and Energy Efficiency Ration (EER). Heating application descriptors are Coefficient of Performance (COP) and Heating Seasonal Performance Factor (HSPF). These are determined under laboratory conditions.

Certified matched system: The Air Conditioning, Heating, and Refrigeration Institute (AHRI; www.ahrinet.org) puts heating and cooling equipment through rigorous certification processes to ensure systems deliver the promised performance at certain test conditions.

Combustion analysis: When fossil fuels are used to heat a home, furnaces and boilers should be adjusted to ensure that they are efficiently consuming fuel and that they have sufficient oxygen to properly combust the fuel. A combustion analysis test, with a properly calibrated meter, is an optimal approach to verify the combustion rate.

Vent system: When fossil fuels are used to heat a home they produce carbon monoxide (CO). Your contractor will verify that the vent piping is the correct size and properly installed. A CO test is supplemental to ensure that the furnace or boiler is venting properly, exhausting all of the harmful gases away from the occupants.

Flow Worksheet

You are going to explore how much heating and cooling is needed during the warmest and coolest times of the year based on the design of your house. Most natural heating and cooling is due to temperatures outside of the house. Thus, we need to calculate the amount of heating and cooling needed based on the exterior features of your house – the roof and exterior walls.

Roof:

The basic conduction equation for heat gain is $q = U \times A \times \Delta T$.

q = Heat gain in Btu/hr
U = Thermal Transmittance for roof in Btu/hr.ft².°F (0.055 is the constant for a roof)
A = area of roof in ft^2
ΔT = Temperature difference in °F; in this case we will use a 20 degrees difference

Roof: q = _____ × _____ × 20

q = _____

Walls:

The basic conduction equation for heat gain is $q = U \times A \times \Delta T$.

q = Heat gain in Btu/hr
U = Thermal Transmittance for walls in Btu/hr.ft².°F (0.2 is the constant for walls)
A = area of exterior walls in ft^2
ΔT = Temperature difference in °F; in this case we will use a 20 degrees difference

Walls: q = _____ × _____ × 20

q = _____

Once you have calculated this value, q, the heat gain is converted to cooling load using the room transfer functions. However, this is a task that it is best left up to professionals. Once HVAC professionals know the value of q, they can better determine what type of heating and cooling unit would be best for your home.

PEX:

Length of PEX piping needed: _____

Volume of water instead the piping when the water lines are charged: _____

Explain what dimension and units you are using in your final measurement.

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Grading Rubric – Flow

Group:_____

	4	3	2	1
Journals	Student's journal entry gives a detailed diagram of what the piping will look like through their home. Hot and Cold are labeled. Student accurately describes where the piping will be laid using both words and pictures.	Student's journal entry gives a diagram of what the piping will look like through their home. Hot and Cold are labeled. Student accurately describes where the piping will be laid using either words or pictures.	Student's journal entry gives a diagram of what the piping will look like through their home. Hot and Cold piping may be labeled. Student vaguely describes where the piping will be laid using both words and pictures.	Student's journal entry gives a vague diagram of what the piping will look like through their home. Hot and Cold are not labeled. Student does little to nothing to describe where the piping should be laid.
Flow worksheet	The worksheet is correctly completed. Student attached all work to show how areas, lengths, and volume were calculated. Work is neat and organized. The ending explanation is precise and easy to understand.	The worksheet is correctly completed. Student attached some work to show how areas, lengths, and volume were calculated. Work is neat and/or organized. The ending explanation is understandable.	The worksheet is completed with some mistakes. Student may have attached some work to show how areas, lengths, and volume were calculated. Work is difficult to follow. The ending explanation is flawed.	The worksheet is partially or not completed. Student did not attach any work. The ending explanation is flawed or missing.
Calculation	When calculating area, volumes, and lengths student used correct measurements and formulas. Correct units were used.	When calculating area, volume, and lengths students were mostly correct in their measurements and use of formulas. Correct units were used.	When calculating area, volume, and lengths students were mostly correct in their measurements and use of formulas. Correct units were rarely used.	When calculating area, volume, and lengths students were rarely correct in their measurements and use of formulas. Units were not used.

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5 Budget

Strand

Geometry

Mathematical Objective(s)

Now that the students have done all of their pre-construction requirements, it is time to calculate a budget and prepare a presentation. The budget should be based on the results of the first 4 lessons.

Mathematics Performance Expectation(s)

MPE.6 The student will use formulas from surface area and volume of three dimensional objects to solve real-world problems.

Related SOL:

G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

G.14 The student will determine how changes in one or more dimensions of an object affect area and/or volume of the object; determine how changes in area and/or volume of an object affect one or more dimensions of the object.

NCTM Standards

- analyze properties and determine attributes of two- and three-dimensional objects

Materials/Resources

- Classroom set of graphing calculators
- Graph Paper
- Rulers
- At least one laptop or tablet per group for research
- "Creating a Budget" worksheet (see attached worksheet)

Assumption of Prior Knowledge

- Students should be familiar with formulas used surface area.
- Students should be able to distinguish the difference between a 2-D and 3-D figure.
- Students should be familiar with presentation software programs (Microsoft Office, Google Docs, etc.).
- Students can draw on experiences they have had with estimating materials for projects, planning a building or actually working on a construction site.

Introduction: Setting Up the Mathematical Task

- Have students take a few moments to reflect on spending money, especially if they have an allowance or even a job.
- Students should consider how much they spend each week on food, then discover what they would spend if they had to provide food for two or more people. A spreadsheet is very useful for this task.
- Students can even calculate loan payback amounts, minimum monthly payment amounts, etc. (see website links below)
- Students will need to determine what is most feasible in their house construction based on their personal wants and needs.

Student Exploration:

Small Group Work

- In groups students will use their laptops to research the different types of budgets:
  http://www.moneycrashers.com/how-to-make-a-budget/
  http://financialplan.about.com/od/budgetingyourmoney/ht/createbudget.htm
- Students can possibly talk from personal experience (or their family's) in regards to budget

Teacher responsibilities during this time:

- Instructors should monitor student progress by posing clarifying questions.
- The instructor can possibly relate his or her own personal experience with creating a budget, reminding students of all the different expenses that go with living in and contributing to society

Monitoring Student Responses

- Students should communicate their thinking cooperatively with others in their group.
- Students should communicate with each other using the vocabulary found in the articles.
- Teacher should appropriately scaffold groups who are struggling to understand both the general idea of the project and the mathematics.
- As a whole group ask students what they mainly used today, directly financed or bank loan? Have them explain their reasoning.
- Students will share their reflections in a whole group setting.

Assessment

- **Journal/writing prompt**

- Students should turn in their models of 2 different types of budgets with at least 2 pros and cons of each idea. See attached "Creating a Budget" worksheet

- Each student is expected to turn in their conclusions and drawings. Some groups may go into more detail than others with regards to the final reflection paragraphs. Considerations may be taken for ELL students or SWD.
- 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)

- If the group having a hard time deciding on a budget, create a presentation with each type of budget used

Strategies for Differentiation

- Give each student in the group a specific assignment.
- Do not allow the group to turn the assignment in until everyone signs the worksheet stating that they understand how the numbers came to be.
- If some students finish quicker than others, they can begin working on the final presentation

- Students need to understand that this work is reaching its conclusion. They need to collate all of their cost sheets, supply lists and contingency plans.
- Students are reminded their final presentation is of a professional nature. They should probably elect a spokesperson for the group with other group members specializing in an assigned phase of the project.

Creating a Budget Worksheet

You should review the costs of each step in the process of building your home. Although your group selected one type of foundation, the blueprint can easily vary. Your group might want to revisit your blueprint and flow worksheets. The cost of the HVAC will be directly related to the interior design. Your group must choose two different roof pitches and types. Record the information in the table and calculate a total for your final presentation. Keep in mind that you do not necessarily want the costs of the 2 choices to be significantly different.

ITEMS	**1st Choice**	**2nd Choice**
Foundation		
Blueprint		
Roof		
HVAC		
TOTAL		

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Grading Rubric – Budget

Group:_____

	4	3	2	1
Notes/ Journals	Student described in full detail two distinct budgets giving thoughtful reasons why a person would or would not wish to follow the budget. Student related to their own life experiences.	Student described in good detail two distinct budgets giving reasons why a person would or would not wish to follow the budget. Student may have related to their own life experiences.	Student vaguely described two distinct budgets giving few reasons why a person would or would not wish to follow the budget. Student did not relate to their own life experiences.	Student poorly or did not describe two types of budgets. No reasons were given as to why or why not the budget should be followed. Student did not relate to their own life experiences.
Powerpoint	The Powerpoint created by the group accurately describes and summarizes each step of the unit. Students included building costs at the end of each step of the unit. Diagrams and words are used to give an understanding of what sort of home they have created.	The Powerpoint created by the group describes the steps of the building process. Students included most building costs at the certain intervals. Diagrams or words are used to give an understanding of what sort of home they have created.	The Powerpoint created by most of group describes most of the steps of the unit. Students included some of the building costs at the certain intervals. Diagrams or words are used to give an understanding of what sort of home they have created.	The Powerpoint created by most of group gives a vague description of the unit. Students included little to none of the building costs at the certain intervals. Little was given in the power point to describe the house they built.
Presentation	Students provide additional information when presenting their power point. They explain how certain numbers were reached. They explain why choices were made. Questions at the end of the presentation were fully answered.	Students read from the power point and gave additional information. They sometimes discuss how certain numbers were reached. They explain which choices were made. Questions at the end of the presentation were answered.	The presentation mostly consisted of students reading from the slides. Rarely did they discuss how certain numbers were reached. They rarely present any choices that could have been made. Questions at the end of the presentation were poorly answered.	Students missed several talking points during the presentation. They rarely discuss how certain numbers were reached or why certain decisions were made. Questions at the end of the presentation were not addressed.

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Presentation

Each group shall create a presentation detailing their work on the construction process, including the budget items at each phase to be summed up at the end.

The presentation shall take the form as a proposal to one of the following:

- the local board of supervisors for approval of the construction
- a lending institution (bank) for approval of a loan

The presentation should last between 10 and 15 minutes. The group should elect one spokesperson to talk through the actual presentation. Each group member shall be responsible for being familiar with at least one phase of the construction process in order to respond to any questions.

The type of home (urban, suburban, rural), foundation, blueprint of floor plan(s), roofing, heating/cooling should all be addressed along with corresponding costs for budget consideration. A comprehensive final budget should also be part of the presentation.