Lesson 1: Framing a Floor

PREREQUISITE ASSUMPTIONS

Before beginning this lesson, students should

- Already have assigned groups - have at least one experienced construction person in each group.
- Have access to a construction calculator
- Have a copy of the textbook

Competencies covered in the lesson and associated homework
Students will be able to:

[from Unit 1 of competency list]
Use a calculator to:
- A.1. perform addition applied to whole numbers
- A.2. perform subtraction applied to whole numbers
- A.2. perform subtraction applied to whole numbers
- A.3. perform multiplication applied to whole numbers
- A.4. perform division applied to whole numbers
- A.5. perform exponentiation to powers of 2 and 3 applied to whole numbers

B.1. translate a verbally stated problem into performing an equivalent computation
B.2. interpret the computed answer to a word problem
B.3. check the reasonableness of a computed answer to a word problem

[from Unit 3 of competency list]
A.2 round decimal numbers up or down to 2 decimal places of accuracy

[from Unit 4 of competency list]
B.3. interpret the computed answer to a word problem

[from Unit 5 of competency list]
A.1. perform addition, subtraction, multiplication, division, exponentiation to powers of 2 and 3, square root taking or combinations of these operations for quantities expressed as measurements
A.2. express the answer with the appropriate units

[from Unit 6 of competency list]
D.1. compute (given sufficient data) the perimeters and areas of rectangles

Notes to Self

- One thing I want to do during this lesson ….

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- One thing I want to pay attention in my students' thinking...

  are they connecting the correct operations to the correct words?

- One connection or idea I want to remember is ...

  that most students know how to add, subtract, multiply and divide, they just don't know the words that relate to the operations.

Suggested Timeline

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
5 minutes	Question 1	Whole Class
8 minutes	Questions 2a and 2b	Groups
7 minutes	Questions 3 and 4	Groups
8 minutes	Discussion on 3 and 4	Whole Class
3 minutes	Question 5	Individual
3 minutes	Discussion on 5	Whole Class
10 minutes	Questions 6 - 8	Groups
8 minutes	Discussion on 6 - 8	Whole Class
5 minutes	Making Connections	Instructor Lead
10 minutes	Practice	Individual or Group

Special Notes: This lesson is a problem with various contexts for adding, subtracting, multiplying and dividing numbers with units.

[Student Handout]

SPECIFIC OBJECTIVES
Use addition, subtraction, multiplication and division to determine information needed to install a floor in a home.

By the end of this lesson you will understand that...

- Addition is → sum, more than, increased by, total, how many
- Subtraction is → difference, less than, decreased by, minus
- Mulitply is → of, times, product, twice (x2)
- Divide is → quotient, ratio, given a total then how many of each...

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- Area of a rectangle is length x width
- Perimeter of a shape is the distance around the edge of the shape

By the end of this lesson you will be able to...

- Correctly interpret words in a problem statement and use the necessary operations to find the result
- Use the construction calculator to add, subtract, multiply and divide numbers of the same units and interpret the results
- Calculate an area of a rectangle given the sides

Definitions:

Linear foot (or lineal foot):

> A 12 inch measurement of length. Because the term linear refers to a straight line, it makes sense to think of linear footage as the straight line measurement of something. ... If you choose a piece that's 12 inches wide and 5 feet long, it's still 5 linear feet.

Plate:

> Normally a 2 X 4 or 2 X 6 that lays horizontally within a framed structure, such as:
> - Sill plate- A horizontal member anchored to a concrete or masonry wall.
> - Sole plate- Bottom horizontal member of a frame wall.
> - Top plate- Top horizontal member of a frame wall supporting ceiling joists, rafters, or other members.

Joist:

> Wooden 2 X 8's, 10's, or 12's that run parallel to one another and support a floor or ceiling, and supported in turn by larger beams, girders, or bearing walls.

Problem Situation #1: Purchasing Materials to Install a Floor

Students are provided a separate, simplified drawing of the Ginkgo house (a recently completed house built by students in the program). [Drawing with no fractions with missing dimensions for the footprint of a house]. Students are also provided a blank drawing from the solution to Question #1 to fill in for the question.
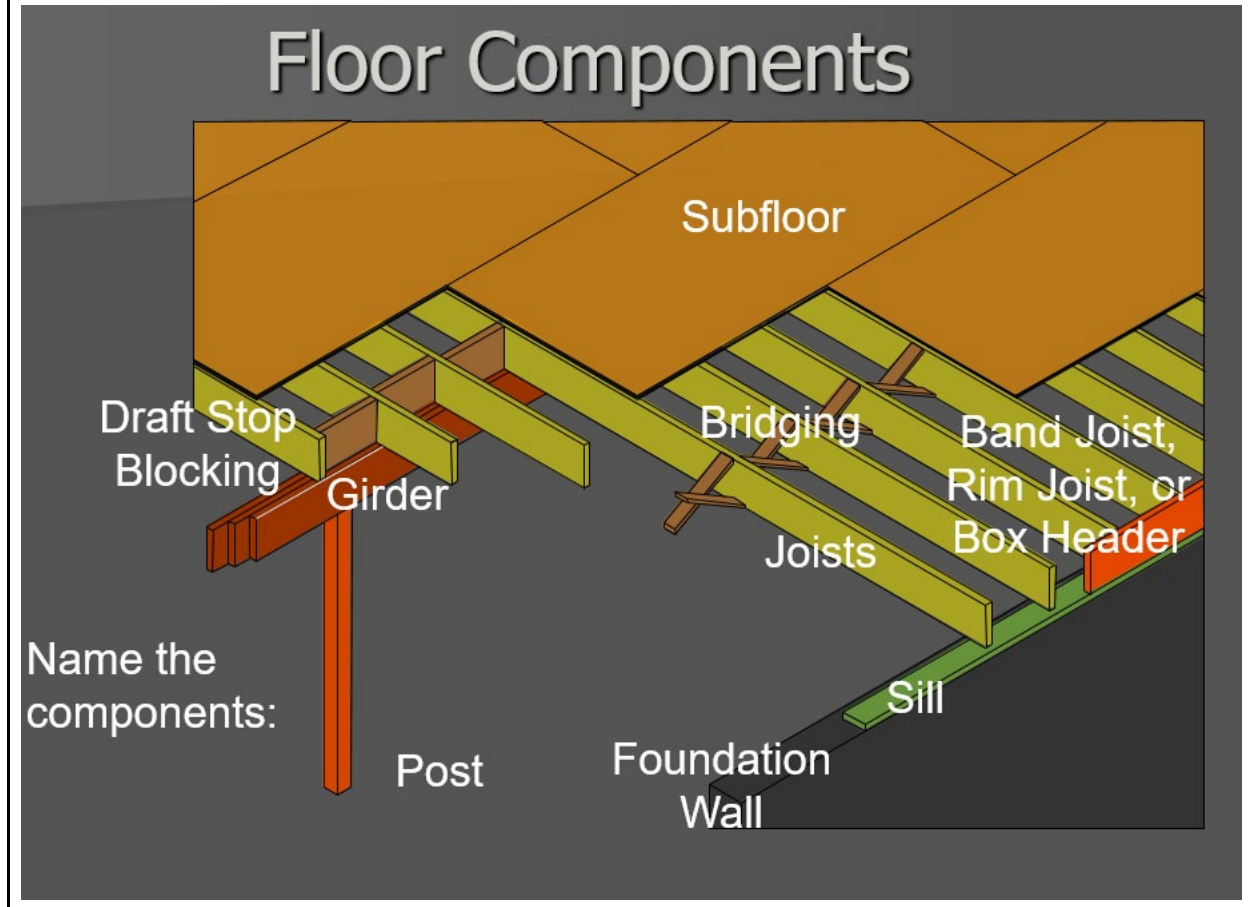
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Congratulations! You have just gotten the job as the general contractor to build a brand new house. The builder has provided you with the plans and you need to verify the materials to start working on framing the floor of the house.

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
5 minutes	Question 1	Whole Class

Notes: this problem is to help the students get comfortable with the situation and gauge how much prior construction knowledge the students have. Since this is the first lesson, it is a chance for the students to see how helpful it is to be part of a group, where some students with work experience know the answers to this, and others don't.

Hand out the image for Question #1. Don't let students take forever on this. Ideally, tell students... *"You've got 1 minute to work on your own to come up with the different components and then I want you to share with your group. The goal is for the whole group to fill in as much of the image as possible."*

Walk around the room while students are working. If some students seem stuck, point out that there are definitions they can use as the beginning of the lesson that may help them.
Look for a group that has the most completely labeled image and make note of that group.
Then, put the blank image on the doc cam and ask students to share answers by having one person in each group come up to the front to label one item on the drawing. Save the most complete group for last. Provide additional detail/clarification if necessary. Provide below image if no group has the drawing completely filled in. Announce *"we are going to focus on just the Sill plate and Subflooring today."*

Since we will be focusing on the Sill Plate and the subfloor, those two components are critical to be brought out.

Be sure to **clearly define – Sill Plate and – Subfloor** with the picture, and any other visuals necessary to ensure students understand what they are.

When doing the share out, don't get stuck in the weeds of why the components are the way they are, just have students give the names, and then, if necessary, show the picture below to help tie it all together and make sure that the key components are out there and understood. Encourage students in the class with work experience to answer questions other students have about the different components.

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1. Label the image provided to you by your instructor with as many different components as you know that make up a floor frame in a house?

Answer shown below:

Floor Components

Subfloor

Draft Stop Blocking

Girder

Bridging

Band Joist, Rim Joist, or Box Header

Joists

Name the components:

Post

Foundation Wall

Sill

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
8 minutes	Questions 2a and 2b	Groups

Notes: An important place to start with any job, is to take a minute and do some estimating of materials. This is necessary to catch calculation errors, and to help the students get more comfortable working with numbers in their heads.
First do 2a as a class, giving students 2 minutes independently to think, then Hand out the image for Question #2b
2b requires students to really look at the drawing. They will need to fill in missing dimensions to do calculations accurately. The emphasis here is to get students to round the numbers given and do some ballpark estimates for missing dimensions to develop the estimate. Ideally multiple strategies

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will be used.

There will be many questions in this course that ask students to estimate. So, since this is the first one, extra time should be given to discuss some key ideas about estimating:

- Estimating, in this sense, means getting a general idea of the total by rounding to make the calculations easier
- In general, estimating focuses on speed and, ideally, doing the work completely in your head
- The point of estimating first is to make sure that, when you do the calculations, the answer is *reasonable* (helps prevent mistakes)
- This work is different than the estimating class, though it aligns. That class is about taking the uncertainty and messiness that is inherent in construction and ensuring there is enough material on site to get the job done.
    - o When students are asked to estimate in this class, they are being asked to determine a reasonable number using rounding techniques before they calculate. This skill is critical for preventing mistakes and is also useful in daily life.

Finally, be on the lookout for students just calculating or using a calculator... that is not estimating.

- o Estimating involves rounding or
- o Estimating is using something you know (like the height of the fence) to determine something you don't know (like someone's height).

2. Estimating is an important skill in construction, and in life.
    a. To get started on the idea of estimating, take a look at the image to the right and estimate the height of the man shown. Explain how you came up with your estimate.
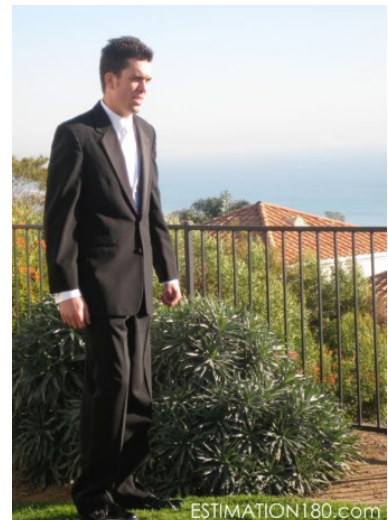
ANSWER: 6' 4"
Possible strategy: fences are usually about 4 feet tall, and it looks about 2/3 as tall as him, so he is probably about 6 feet tall.

b. Without using your calculator, <u>estimate</u> the total linear feet of sill plate material needed for the house floorplan shown in the handout. Write down your estimate and *explain* your strategy for finding it.

ANSWER:
Possible strategies are:

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- *Round the 38' to 40' and 'slide' the walls out to form a rectangle that is 20' by 40'... so, 20' + 20' + 40' + 40'= 120 feet*
- *Round 11' to 10' and 38' to 40' and 22' to 20' and fill in the missing dimension rounding to 30'... all walls added in the rounded form is then 40' + 20' +10' + 10' +30' + 10' = 120'*
- *<u>Incorrect Strategy</u>: just add them all on the paper: 38' + 22' +11' +11' + 27' + 11' = 120' Though the addition in #3 is not that hard<u>, it is not estimating</u>.*

A common error that is likely to be seen is students missing one wall.

A couple of additional notes/connections to help students make:
- make sure students understand that 'linear feet' is the length of material
- Talk about how rounding to the nearest 5 or 10 feet as an extremely common and effective way of estimating quickly
- After they do the calculating in #3, point out that the estimate ended up being the same as the actual because they were rounding down and up and it happened to balance out perfectly.

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)
7 minutes work. 8 minutes discussion	Questions 3 and 4	Groups work, whole class discussion

Notes:
The point of question #3 is to get students to calculate the perimeter of the house. Be sure to introduce that vocabulary word during the discussion and point out that it is the distance around the edge of any object, no matter how weird the shape.
The point of question #4 is to realize that doing math in a classroom like they did in high school, is different than doing math on the job. The math they need to do for #4 is to recognize that they can't just take the total perimeter and divide by 12 feet. If they do, they will not purchase enough wood for the job. They need to deal with the fact that the plate material must be at least 6' long, so they can't use scrap.
In #4, the reason that scrap shorter than 6 feet is not used is because the sill plates are held down by anchor bolts and those bolts are spaced about 6 feet apart and you want each plate to be held down by at least 2 bolts.

3. Now <u>calculate </u>how many linear feet of sill plate material is needed for the house. Show the calculations you made (write down the calculations) and include units in your answer.

Students will need to use subtraction to fill in missing dimensions on the house.
Students will need to use addition to calculate the linear feet of sill plate material. This is the

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perimeter of the house.
Answer: 238' + 22' +11' +11' + 27' + 11' = 120' linear feet
Extension: the issue of each plate being 5.5" wide complicates the calculation. So, 120' is not actually correct because of the way the boards come together at the corners

4. You can purchase the plate material in 12' lengths, but you cannot use any scraps shorter than 6 feet. Based on these limitations, how many pieces of 12' sill plate material will you need? Be sure to show or explain how you determined your answer.

12' lengths are typical for plate material. Students will need to use division to determine the number of pieces they need. There are a number of different strategies and answers to this depending on whether or not you use the scrap from one length along another wall.
Possible answers *are:*
Simplest: *take the answer from #3 and divide it by 12: 120/12 = 10 pieces* ← least accurate because it assumes all waste is used, which it typically is not.
More Realistic: *Typically, scraps shorter than 6 feet are not used.* So, based on the drawing,
 1. *look at each wall separately: 3 pieces on the 27' wall, 1 piece on each 11' wall, 4 pieces on the 38' wall, 2 pieces on the 22' wall = 12 pieces*
 2. *BEST: use not a full 12' length on the 27' wall, instead use a 9' length and a 6' length. Then, use the extra 6' length on the 38 foot wall which allows for 1 less piece... = 11 pieces*
11 or 12 pieces are both reasonable numbers to use for #5. Let each group use their answer (as long as it is 11 or 12)

Take-Aways for #3 and #4 (if they didn't come up in discussion, make sure to write them down yourself or state out loud for the students):
- Perimeter – distance (length) around the edge of an object. Often see formulas for Perimeter...
  - Ask if anyone remembers the formula for the perimeter of a rectangle? P=2L + 2W...
  - Point out how they figured it out without a formula because it is just adding up all of the sides.
  - Exception... a circle: formula is needed. It is C = pi*d (Define each variable and note that we'll use this later in the course)
- In most math classes, asking for the number of boards would have just been a simple division problem (Perimeter / length of one board). But doing it on the job, it is important to know standard practices and how it's being used to really be able to answer the question.
- Point out that there were different ways to determine how many boards... they will do that more in their estimating class
- Ask students to name the math operations they have used so far... addition, subtraction, division, rounding (point to it in the lesson as they identify it)

Duration	Activity (Indicate question number)	Suggested Structure (Indicate group, whole class or individual work)

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3 minutes work. 3 minutes discussion	Question 5	Individual work

Notes: Students will use the price supplied: a 12' treated 2x6 is $8.67. In future, problem could be modified to force students to search online for a price.

Students should be working individually *with their calculator* to complete this multiplication problem.

Walk around the room while students work. Look for students that do not seem to be starting. After about a minute, go to those students and ask a group member to help them.

Include in the discussion that the price is 'each' or 'per piece,' which makes it a 'unit price.' They could possibly buy materials in different units… this will come up a lot in the course.
Extensions/things to possibly discuss...
-          what if they used 8' pieces? How does that change things?

5. Now <u>calculate </u>the exact cost of the lumber assuming you are buying 12' treated 2x6 boards from Home Depot for $8.67 each (for now we will ignore tax). Round your answer to the nearest dollar.

answer: 8.67 x 11 = $95.37 so $95 OR   8.67 x 12 = $104.04 so $104

Duration	**Activity** (Indicate question number)	**Suggested Structure** (Indicate group, whole class or individual work)
10 minutes work. 8 minutes discussion	Questions 6 - 8	Group work Whole class discussion

Notes: Questions 6 and 7 require students to calculate the area of the floor. No formulas have been given. Spend 2 minutes or so having the groups discuss the difference between linear feet and square feet.
  • If students ask to use a formula, first ask if anyone in the group remembers the formula for the area of a rectangle. Get a student from the class to say what it is, then write it on the board.
Question 6 asks students to estimate. They will need to estimate both the area and the price. BEFORE the students start working, remind them, the estimation technique to use. Tell them
  • **"In #6, Round *before* calculating. Round enough that you can do the math in your head. It's okay to round multiple parts (both the area and the charge). *Resist* the urge to pull out a calculator. In #7 you will get to calculate!"**
  • *Possible tip* to share if students are struggling: If that means you have to round a lot, then try to round one number down and another number up to try to balance things out

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Ask students to "**make sure everyone in the group has an answer to #6 before moving on. Once everyone agrees on #6, show the answer to me before moving on to #7 and #8.** "
- When looking at student answers for #6, look for
  - Answers between $500 and $600.
  - Work written on every student's paper
  - If time, ask a student to explain the estimation strategy
- Take note of strategies from different groups and pre-select two groups to share their strategies during the group discussion that hopefully used different estimating techniques
- Either have the two groups write their work on the board including how they cut the image, or demonstrate cutting the image different ways on the whiteboard as students talk through their strategies for finding the area.

6. It is now time to <u>estimate</u> how much you will charge to lay the subfloor if you charge $1.19 per square foot. Be sure to write down your answer and the strategy you used to find it.

Answer:
Possible area estimates:
- 40'x 10' = 400 sq ft and 10' x 10' = 100 sq ft , so 500 sq ft
- 40' x 20' = 800 sq ft subtract 30' x 10' = 300 sq ft … 800 – 300 = 500 sq ft
- 20' x 10' = 200 sq ft and 30' x 10' (round 27' up and 11' down) = 300 sq ft, so total is 200 + 300 = 500 sq ft

Charge estimate: 500 sq ft x $1.00/sq ft = $500
Or, round charge up... 500 sq ft x $1.20 = $600 since 0.20 is 1/5

7. Now calculate the exact amount you will charge. Show the calculations you made (write down what you typed into your calculator) and include units in your answer.

Students will now calculate the area of floor. As this is an L-shaped building they may employ a couple of strategies.
Possible strategies are:
- *Calculate the area of a large rectangle, 38' x 22' = 836 sq ft. Then subtract the area that isn't in the building, 27' x 11' = 297 sq ft. So, 836 sq ft – 297 sq ft = 539 sq ft.*
- *Calculate the two rectangular areas and then add. So, 11' x 38' = 418 sq ft and 11' x 11' = 121 sq ft. 418 sq ft + 121 sq ft = 539 sq ft.*

Answer: 539 sq. ft. * $1.19 per sq. ft = $641.41

8. Compare your answers in 6 and 7. Are they close? Why or why not?

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The $500 estimate is so low because the area estimate was low AND the price per square foot was rounded down. Point out that maybe they would have done better rounding $1.19 up to something higher to account for rounding the 11' sections and 22' foot section down...

So, maybe 500 sq ft * $1.50? $500 + half of that... $250 = $750. Now that is pretty high. The estimate with $1.20 is closest, but also possibly hardest to do without a calculator.

Take away: The goal with estimating isn't necessarily to get the 'right answer.' It is to be in the ballpark so you know if you made a mistake, or so you can plan.

MAKING CONNECTIONS

Record the important mathematical ideas from the discussion

Making Connections: Main Ideas to Highlight

- In construction, there are often many 'correct' answers depending on how you handle waste
- Spending time estimating/approximating at the beginning of a job can prevent mistakes later
- Area of a rectangle is calculated by multiplying the length and width of the sides
- Paying attention to language is important... notice in Question #3, 'how many' meant add it all together, but in Question #4, 'how many' meant divide
- Asking to find the total length around the outside is asking for the 'perimeter'
- Asking to find the total flooring is asking for the 'area'
- Notice the units for length: feet
- Notice the units for area: square feet

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Practice/Homework

Spend time at the beginning of the next class discussing the estimation strategies for #27
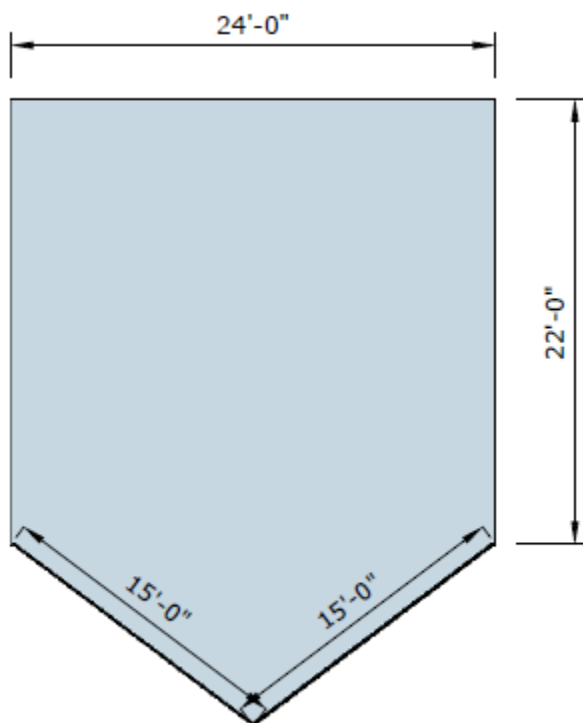
Pg 3   24. As is

Pg 5   29. As is

Pg 12 27. First estimate and then complete the problem. As is

        28. As is

Pg 87 21. As is. The cost for grass seed is $0.75/sq ft. How much will seeding the yard cost?

Pg 97   2. Using any method.

What is the perimeter of the blue figure?

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A former basketball star decides to build his home in the shape shown below. What will the perimeter of his home be?