Math-in-CTE Lesson Plan Template

Lesson Title:		Lesson # 1
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Occupational Area: carpentry		
CTE Concept(s): construction materials (estimating wall stud quantities)		
Math Concepts: problem solving, ratios, converting fractions to decimals, converting feet to inches		
Lesson Objective:	Students will use equations and problem solving skills to estimate the quantity of studs needed for walls; differentiating between solid walls and walls with large openings.	
Supplies Needed:	whiteboard, calculators, markers, pencil, paper, copy of worksheet for students, copy of answer key for worksheet	

THE "7 ELEMENTS"	TEACHER NOTES (and answer key)
1. Introduce the CTE lesson. "We'll be estimating materials today." "We'll be finding the number of studs needed for a wall. This would be the same process for joists or rafters." "At the end of this class we're going to have a nice equation that we can use to calculate quantities of framing members for many applications."	

2. Assess students' math awareness as it relates to the CTE lesson.	
A few quick review questions before we get started "How many inches in a foot?"	write 1' = 12" on the board
How would we convert 4'-6" into inches?	# of feet times 12, add the inches (4*12+6), answer = 54"
How would we convert 39" into feet?	divide by 12, answer = 3.25'
"What are the common spacings we use in framing?"	12", 16", 24" on center (write student answers on board)
Who can tell me what a **ratio** is	(**ratio** compares two numbers using division, can be written 12:16 **or** 12/16)
3. Work through the math example *embedded* in the CTE lesson.	
example: 16" on center Ask student for a length of a wall (have students offer suggestions, pick an easy number for the first example, like 32') Say we're spacing studs 16" on center (o.c.), we need to find out how many times 16" goes into 32'. Since our spacing is in inches, we'll take the length and multiply by 12, this will be the length in inches. Then we divide by the spacing, 16". This will tell us how many spaces we have.	write the equation on the board as you walk through each step of it L*12 , then $\frac{L \bullet 12}{16}$, then $\frac{L \bullet 12}{16} + 1 = \# \, studs$ $\frac{32' \bullet 12}{16} + 1 = 25$
Now we need to add one more stud to this, because we need a stud on the beginning. If you have a 16" spacing you need two studs, one on each side. A 32" space needs three studs, one at the beginning and one after each spacing, etc...	draw visual showing why we add 1 extra stud to the equation (16" spacing with 1 stud, 32" spacing with 3 studs etc...)
example: 24" on center	

Do a similar example with a 24" o.c. wall. Use a number that won't give a whole number answer, like 31'. Go through the equation with 24, have a student calculate the answer We get 16.5 spacings, so even though there's 0.5 space on the end we still need a full stud there so we always round up whenever it's not a whole number. Have students give more lengths for extra examples using different spacings. Have students walk through the examples.	$\frac{L \bullet 12}{24} + 1 = \#\,studs$ 31*12/24+1 = **17** Draw diagram on board showing a wall with a fraction of a spacing on the end, laying out the stud placement.
4. Work through *related, contextual* math-in-CTE examples. introduce general equation: So whatever the length of the wall is, we're multiplying by 12 to convert it into inches. We need to do this because most common spacings are given in inches. We're dividing by the spacing, because we want to see how many units of spacing will fit into that wall. So if we have a 16" spacing, we divide by 16 because that tells us how many 16" units fit into our length.	write general equation on the board: $\frac{L \bullet 12}{S} + 1 = \#\,studs$ Draw a line on the board, then divide it into equal segments for an example.
5. Work through *traditional math* examples. Let's look at the equation for 16" spacing. Look at the first part of the equation, can I rewrite it like this? Why? (Look for students to tell you that you can multiply and divide in any order without changing the answer because of the order of operations. If students aren't understanding well, plug in some lengths and calculate the answer in the different ways.) Because of the **the commutative property of multiplication** *we can rearrange the terms without changing the answer, a*b*c = c*b*a.* Division can be described as multiplying by the inverse.	on board $\frac{L \bullet 12}{S} + 1 = \#\,studs$ on board: $\frac{L \bullet 12}{S} = \frac{L}{S} \bullet 12 = L \bullet \frac{12}{S}$ on board to show commutative property:

Circle or highlight $L \bullet \frac{12}{S}$ *on the board*	$\frac{L \bullet 12}{S} = \frac{L}{1} \bullet \frac{12}{1} \bullet \frac{1}{S}$
This is the most useful way to write it. Here we have the length of the wall being multiplied by the **ratio** of 12" to our spacing.	
A spacing of 16" gives us the **ratio** 12/16	
We can take this **ratio** and reduce it to simplest form so it's easier to use, right? What does 12/16 reduce to?	write 12/16 on board
Who can tell me what ¾ is as a decimal?	(¾, write answer on board)
So let's go back to the equation, for 16" spacing we could write the equation: length times the ratio, which equals .75, plus one.	(.75, write on board)
So for any 16" spacing, we can take the length of the wall in feet, multiply it by .75, and add 1 more stud for the beginning.	on board: $L \bullet .75 + 1$
Let's change the ratio for a 24" spacing, who can reduce this ratio to simplest form? Who can tell me what ½ is as a decimal number?	on board: 12/24, reduces to ½, equals .5
So for a 24" spacing our equation can be written like this.	on board: $L \bullet .5 + 1$
How about if we were doing timber framing, and our posts are spaced 4' o.c. How do write this ratio? What do I put as the **numerator**? (12) What's the **denominator**? (48) We need to make sure the spacing is in inches, so it's 48" not 4' as the denominator! Who can reduce this ratio? What's ¼ as a decimal?	*have students dictate answers for this example* on board: 12/48 *not 12/4!* 12/48=1/4=.25 *numerator: the number on the top of a fraction or ratio* *denominator: the number on the bottom of a fraction ratio*
Bonus math connection: "You might recognize this type of equation from math class. This is a type of ***linear equation in slope-intercept from****."* *You've probably had to use equations written like this:* y=ax+b*. We have* studs = .75x+1	

6. Students demonstrate their understanding. Handout worksheet with different examples, have students complete worksheet alone or in pairs. Afterwards, go over the worksheet as a group, address any questions or issues as they arise.	
7. Formal assessment. Assessment will vary from a quiz on take-offs to doing a take-off for a construction project.	