Math-in-CTE Lesson Plan Template

AT06 - Calculating Cubic Inch Displacement		Lesson #1
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Occupational Area: Automotive		
CTE Concept(s): Cubic Inch Displacement		
Math Concepts: Order of Operations		
Lesson Objective:	Given the bore and stroke specifications of an engine, a student will be able to: calculate cubic inch displacement (cid). Calculate the change in cid if the bore or stroke has been changed during a machining process or internal parts replacement with after market parts such as a stroked crankshaft.	
Supplies Needed:	16 calculators, CID formula, engine specifications, engine block and crankshaft, piston and rod, a wooden cube to represent a cubic inch.	

THE "7 ELEMENTS"	TEACHER NOTES
INE / ELEWENIS	(and answer key)
1. Introduce the CTE lesson.	Students should answer That it represents the size of the engine in
You hear people refer to cars that have a 327 or 400 cubic inclengine. But what do the numbers really mean?	cubic inches. The smaller the number, the smaller the engine and the larger the number the larger the engine.
	This does not mean that a larger engine is more powerful, it's just larger.
Let us first look at the terms used in the cubic inch displacement formula	
Bore	Bore is the diameter of a cylinder.
Stroke	Stroke is the distance the piston travels up and down within the cylinder.
Number of Cylinders CID	Cylinder is located in the cylinder block. This is where the piston is located.
	CID is the total cubic inch displacement of all cylinders.
Why would the bore change?	Student should answer When an engine is disassembled and inspected it may be discovered that a cylinder wall has been damaged. One option would be to bore the cylinder to return it to usable condition. In a multi cylinder engine this would require that all cylinders be bored.
	Another reason to increase the bore is for a performance increase.
Why would the stroke change?	Students should answerstroke is changed either by exchanging the crankshaft with a different crankshaft from the same engine family or installing an aftermarket crankshaft with a different stroke.

Assess student's math awareness as it relates to the CTE lesson.	
Today we are going to calculate the Cubic Inch Displacement of Engines. Does anyone know how to do this?	Usually students do not know how to calculate CID.
Before we can calculate the CID, you need to know the formula.	Write the formula on the board large enough to write numbers or draw pictures under each part of the formula. Students do not need to memories the formula. They only need to know it exist.
CID = .7854 * (Bore ²) * Stroke * NOC	
Explain what each of the parts of the formula represents. Review	
Vocabulary: CID, .7854, Bore, Stroke and NOC.	CID = .7854 * (Bore ²)* Stroke * NOC
	CID is the answer to the formula, the total cubic inch displacement of all cylinders in the engine.
	.7854 is the difference between the volume of the cylinder and the rectangular prism it is bored out of or 1/4th of π . Draw a picture of a 2" square then draw a 2" circle inside of it. Circle represents .7854 of the square.
	Bore is the diameter of a cylinder. Bore * Bore. This part of the formula is always done first. This is called ORDER OF OPERATIONS.
	Stroke is the area the piston travels in the cylinder, also referred to as the "swept area". Draw cylinder and show piston travel.
	NOC is the Number of Cylinders in the engine.
	Also note that in the student's text book and on internet sites the formula is expressed with an (X) to mean multiply where as in math class it is expressed with an (*).

3. Work through the math example <i>embedded</i> in the CTE lesson.	
	Pass out calculators for students to use.
With the CID formula on the board for students to copy.	CID= = .7854 X (Bore ²) X Stroke X NOC
Review following examples with students. Students should write these examples in their notebooks for future reference.	CID = .7854 * (Bore ²) * Stroke * NOC
	1st Example: Stock bore and stroke.
	Bore 4 inches, Stroke 3 inches, NOC 8
	Students should be putting information into equation
	CID = .7854 * (4 ²) * 3 * 8
	Example to students that they need to calculate Bore first.
	CID = .7854 * 16 = 12.57 (Have students round to nearest hundredths)
	Then CID = 12.57 * 3 = 37.71 (Have students round to nearest hundredths)
	37.71 represents the displacement of only ONE cylinder
	37.71 * 8 = 301.68 CID. Manufacture would call this engine a 302 cid.

 Work through <i>related, contextual</i> math in-CTE examples. 	-Let's Bore out the cylinder .030 and see the difference in Cubic Inch Displacement. Students know that the CID will be greater, but they will be surprised by how little of an increase the CID is from the stock (original) bore.
	2 nd Example: Same engine with a .030 overbore.
	Bore 4.030 inches, Stroke 3 inches, NOC 8
	Students should be putting information into equation
	CID = .7854 * (4.030 ²) * 3 * 8
	Example to students that they need to calculate Bore first. Round to the nearest hundredths
	CID = .7854 * 16.24 = 12.75 (Have students round to nearest hundredths)
	Then CID = 12.75 * 3 = 38.25 (Have students round to nearest hundredths)
	38.25 represents the displacement of only ONE cylinder
	38.25 * 8 = 306
	306 - 301.68 = 4.32, which is the difference of the bore increasestudents would have expected this to be much more of an increase.
	3 rd Example: Let's increase the stroke by .030 .
	Bore 4 Stroke 3.030 Cylinder 8
	CID = .7854 * (4 ²) * 3.030 * 8
	Remember to remind students to calculate Bore first (Students will round to the nearest hundredths)
	CID7854 * 16 = 12.57

12.57 * 3.030 = 38.09
38.09 represents the displacement of one cylinder
38.09 * 8 = 304.70
304.70 – 301.68 = 3.02, which is the difference in cubic inches of the stroke increase from the original problem
The difference between the bore increase and the stroke increase was:
306 - 304.7 = 1.3 cubic inches

5. Work through traditional math	
examples.	
In math class this process would be called the	
ORDER OF OPERATIONS.	
Pass out Order of Operations worksheet.	
AT-06 in class work.	
	www.math-drills.com/orderofoperations.shtml
	http://www.math-drills.com/orderofoperations/000_int2_noneg_004.pdf
	The above web site can be used by a sub for classroom work or for extra practice.

6. Students demonstrate thei understanding.	
Now that we've practiced together calculate these engine specifications to get the cubic inch displacement.	Pass out Student Worksheet # 1
7. Formal according to	
7. Formal assessment.	CID Assessment
pages	Pass out coloulators for students to use
	Pass out calculators for students to use.
	Ask if there are any questions before they take the assessment.
	Peas out Cubic Inch Displacement accessment
	Pass out Cubic men Displacement assessment.
	cars that were driving around on the road when your cup holder sat right beside you.