Core Mathematics for MCTI CTE Teachers

# Part I - CTE Mathematical Thinking taken from the ideas in the *CC Standards of Mathematical Practice:*

1. Spend time and energy on problems that are important to your trade. Practice frequently and over time for deep understanding and retention.
2. Connect the math in the program to academic math students learned in previous grade levels. Review the academic math as needed.
3. Develop speed and accuracy with simple calculations that are part of your trade area, such as, conversions between different forms of numbers (fraction, decimal, and percent) or measurements (inches, feet, ounces, mL, etc.).
4. Memorize math facts, equivalents, or formulas as needed to do the job.
5. Fully understand and be able to work easily with a problem or concept before moving on to a different or related concept; work from the simple to the complex.
6. Use the appropriate math concepts as part of the job or task such as estimation, modeling, problem solving, and reasoning without prompting.
7. Know what math is needed for this job or task, why it is needed, and be able to use it.

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# Part II - What CS math instruction and practice looks like in the classroom:

1. Students use several interconnecting sentences to explain their thinking.
2. Students talk about each other’s answers, thinking, and work.
3. Students use general and program/trade specific language in their oral and written explanations and discussions.
4. Students show their work and can justify their solution process and answers.
5. Students can revise their work and justifications.
6. Students believe they can learn this math and be good at it by asking questions, checking and revising/correcting.
7. Students persevere to make sense of the problems at points of difficulty, challenge or error.

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The 8 Core Standards for Mathematical Practice

Procedural skill *and* understanding of mathematical practices that connect to program content to increase student understanding and engagement.

*What are some questions that I can use with students to connect the Standards for Mathematical Practice to my current instructional strategies?*

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| **Standards for Mathematical Practice** | ***Ask the students to explain to you, a partner, a team, orally or in a written statement (Collins Writing Type 1 or 2)*** |
| Make sense of problems and persevere in solving them. | * *Did your strategy work? Why or why not?* * *How can you modify it?* * *Do the results make sense?* |
| Reason abstractly and quantitatively. | * *What happens if this value/measurement/parameter changes?* * *Are the units appropriate?* * *Do the results make sense?* |
| Construct viable arguments and critique the reasoning of others. | * *In what way can you prove your work and/or justify your thinking?* * *How is your approach the same or different from other’s work?* * *Is one approach easier/more difficult/faster/more accurate than another?* * *What questions do you have about this approach?* * *What information do you need to make it easier to understand?* |
| Model with mathematics.   * Use diagrams, tables, graphs, flowcharts, formulas to justify thinking, show solution process, prove solutions | * *What are the important quantities in a practical situation?* * *Check your solution using a different approach.* * *Can you show this in another way - using another model, easier to understand, less complicated values?* * *Why do these different approaches show the same thing?* * *Does this model show or prove what you were looking for?* |
| Use appropriate tools strategically.   * Pencil, paper, concrete models, ruler, protractor, calculator, spreadsheet, computer & software | * *What tools can I use to help me solve this problem?* * *What was your estimate?* * *What errors are possible? How do you prevent them or recognize it if you make a mistake?* * *What happens if a value/measurement/parameter changes?* * *What resources are available to explore this problem further?* |
| Attend to precision. | * *How have you defined, identified and labeled the symbols, numbers, diagrams, and figures?* * *How does the definition of this term help you to find the appropriate solution or solution process?* * *Use mathematic or technical terms when describing the problem, solution process, or justification of solution.* * *Have you used the equals sign appropriately?* * *Is the solution usable in this form? Does it need to be reduced, rounded, or changed to an equivalent?* |
| Look for and make use of structure. | * *What pattern or structure do you see?* * *What information is there that can help you solve the problem or give a clue to a solution process?* * *Can you break this down into several parts?* * *What challenges will you face as you put the parts back together?* * *How does this part/number/formula/intermediate solution fit into the overall problem?* |
| Look for and express regularity in repeated reasoning. | * *Is this problem similar or different compared to other ones that you have worked with?* * *Are any of the calculations repeated?* * *Do you know some shortcuts?* * *Are there some strategies that you used in previous work that will help to solve this problem?* * *How can you modify your work to make the solution process simpler?* |

***Improving my students’ success with trade related math problems by including the Core Standards of Mathematical Practices***

Find one example problem for each area of math content that you would expect your students to be able to do (without reminders, instruction, help, etc.) in the course of their work or as part of the NOCTI test. Examples can be found on the NOCTI guides, your textbook or teacher materials, your experience, your projects, etc. You can have as many problems as you believe are needed to cover the range of mathematics content you would expect students to be able to do or that are included as part of your POS task list.

**For each Example Problem you would expect your students to be able to do:**

* If needed, build that example into a word problem that makes sense in your industry by adding a scenario or situation. Make it detailed enough so that students have to practice critical and analytical reading skills to pick out the important information.
* Create 2-3 questions that use the Core Standards for Mathematical Practice – see the table of questions in the Core Standards for Math Practice handout. Of course, one or more of the questions will require mathematical calculations to answer or solve the problem, but they can be expanded to include writing the solution in several appropriate ways or equivalent units, comparison to an estimate, or using alternative solution methods.
* Initially, allow students to work in pairs or teams to determine the solution, but require that everyone write an answer (use Collins Type 1 or 2) and justify their work. Repeat the same problem (change the numbers, if you feel you need to) until students can do it on their own without prompting.
  + Of course due to their circumstances, there may be students who will never be able to do this without scaffolding from the instructor. Provide it as needed.
  + On the other hand, provide extensions by changing parameters, units, etc. for those students who have math skills that enable them to solve this problem with expertise.
* Work on one type of problem until students have mastered the solution process. Revisit this problem every so often to keep their skills sharp.
* Include problems that students have studied in tests and/or quizzes, warm-up/transitional activities, etc. If this math is important to your trade, make sure your students are practicing it all the time.

**Some Other Ideas:**

1. Insist students memorize important math facts and equivalents that are important for your trade. Test repeatedly and frequently.
2. Post formulas, equivalents, important math facts, etc. in your classroom / lab for reference as needed. If students need to know it for the work, it should be on the wall. Cover if you are testing for memorization, uncover for everyday work.
3. Provide calculators as you see fit with regards to your industry standards and expectations.