**Math Practices Summary Sheet** **Handout 3.2**

| MP | Indicators | Students might think or do: |
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| 1: **Make sense of problems and persevere in solving them** | ✓ explain to themselves the meaning of a problem<br>✓ look for entry points to its solution<br>✓ analyze givens, constraints, relationships, and goals<br>✓ make conjectures about the form and meaning of the solution<br>✓ plan a solution pathway<br>✓ consider analogous problems<br>✓ monitor and evaluate progress and change course if necessary. | ▪ "I tried that approach to solving the problem and it didn't work. What's another way I can try to solve it?"<br>▪ "What's a useful way to begin working on this problem?"<br>▪ They can set up a series of steps to follow to get themselves to the answer.<br>▪ "There's another problem I've done that's like this that might help me here."<br>▪ "This isn't working; I need to try something else." |
| 2: **Reason abstractly and quantitatively** | ✓ make sense of quantities and their relationships in problem situations<br>✓ *decontextualize* -- abstract and represent a problem situation symbolically and manipulate those symbols without attending to their referents<br>✓ *contextualize* -- pause during problem solving to connect symbolic work back to the context of the problem<br>✓ Pay attention to the important quantities and relationships between them<br>✓ use representations to highlight those relationships and the underlying mathematical structure of a problem | ▪ "How can I capture important information in a diagram or model?"<br>▪ "What solution path does this diagram or model imply?"<br>▪ "OK, I've done all these calculations; now, what does that mean in the problem? Does my answer make sense for answering this problem?"<br>▪ Given the problem: *There are 3/5 as many boys as girls. If there are 45 boys, how many girls are there?,* a student can create a diagram that shows the relationship between the number of boys, of girls, and of all the children together. |
| 3: **Construct viable arguments and critique the reasoning of others** | ✓ make conjectures and build a logical progression of statements to explore the truth of their conjectures<br>✓ analyze situations by breaking them into cases<br>✓ recognize and use counterexamples<br>✓ justify conclusions, communicate them to others, and respond to the arguments of others<br>✓ distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is | ▪ A student can state a rule for a pattern, and can explain why their rule works for that pattern.<br>▪ When someone claims "multiplying two numbers gives you an answer bigger than either the numbers," a student can think about:<br>-- what happens when you multiply 2 whole numbers;<br>-- what happens when you multiply by a fraction;<br>-- what happens when you multiply 2 fractions as separate possibilities to consider. |

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| 4: **Model with mathematics** | ✓ make assumptions and approximations to simplify a complicated situation, realizing that these may need revision later<br>✓ identify important quantities in a practical situation<br>✓ map their relationships using such tools as diagrams, two--way tables, graphs, flowcharts and formulas<br>✓ analyze those relationships mathematically to draw conclusions<br>✓ interpret their mathematical results in the context of the situation | ▪ When starting to solve a problem, a student makes a table, a flowchart or graphs the data to see if that representation will shed light on the problem solution.<br>▪ When working on a problem, a student might estimate or round off a certain quantity *for the purpose of moving through the calculation to see what the results are* – knowing they will have to readjust to be more precise. |
| 5: **Use appropriate tools strategically**<br>(Ex: pencil and paper, concrete models, ruler, protractor, calculator, spreadsheet, computer algebra system, statistical package, or dynamic geometry software.) | ✓ are familiar with tools appropriate for their grade or course and can make sound decisions about when each of these tools might be helpful<br>✓ identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems | ▪ A student wants to see how the difference between values in a table changes, so she begins by making a table, then decides to put the information in a spreadsheet to more easily do the calculations, and draw conclusions from the results.<br>▪ A student is having trouble visualizing a situation with a geometric shape, so he creates it in a geometry software application and is able to move the shape around to see how some parts of the shape change while keeping certain characteristics of the shape the same. |
| 6: **Attend to precision** | ✓ use clear definitions in discussion with others and in their own reasoning<br>✓ state the meaning of the symbols they choose, including using the equal sign consistently and appropriately<br>✓ are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem<br>✓ express numerical answers with a degree of precision appropriate for the problem context | ▪ A student rewrites his explanation to a problem using appropriate mathematics vocabulary.<br>▪ A student learns why it is incorrect to write 14 + 4 = 18 + 5 = 23 x 2 = 46.<br>▪ “My calculator says 3.581279, but since I’m asked to find the number of inches, that’s not a number that makes sense to write for measurement in inches. I’ll say 3.5 or 3.6.” |

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| 7: **Look for and make use of structure** | ✓ look for similar mathematical structures across seemingly different problems<br>✓ use those similarities to help them reason about how to solve a problem<br>✓ can step back for an overview and shift perspective<br>✓ can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects | ▪ "Since (problem A) and (problem B) are structurally the same, what do I know about solving (prob A) that will help me think about solving (prob B)?"<br>▪ "Figuring out what to do with 3 (x + 2) is just like the work I did in (?th) grade when I learned that 7 x 8 is the same as (7 x 3) + (7 x 5)."<br>▪ Would recognize that 17 + 2 (X + 1) will be odd because 2(x+1) is even (since it's 2 times some number) and 17 is odd, and an odd amount + an even amount will be odd.<br>▪ Noticing that all numbers that have a remainder of 4 when divided by 5 will end in either 4 or 9<br>▪ "I recognize that 1/3 (A + B + C) is really just the same as finding the average of 3 numbers." |
| 8: **Look for and express regularity in repeated reasoning.** | ✓ look both for general methods and for shortcuts in the calculations, understanding why the shortcuts work<br>✓ maintain oversight of the problem--solving process, while attending to the details of the calculations<br>✓ continually evaluate the reasonableness of their intermediate results | ▪ "When I divide 15 by 9, the 9 keeps 'going in' 6 times .... over and over again. That means I have a repeating decimal."<br>▪ "I solve this problem using 8 adults. Then I solved it using 10 adults, 12 adults and 20 adults. What's the same about my solution steps each time? How can that help me describe a process or an equation for the problem?"<br>▪ (When a student is immersed in some calculations, they can stop and think) "Wait, where am I going with this? What does 5.76 represent? Where am I in the process of solving this problem?"<br>▪ "Wait, I can't just write 7.2 because you can't have 7.2 children in a group." |