

STANDARDS FOR MATHEMATICAL PRACTICES OBSERVATION TOOL

Created by Melisa Hancock for KATM/KSDE CCSS Summer Academy 2011

Overall: The mathematics tasks focus on developing **CONCEPTUAL UNDERSTANDING** and encouraging **ALL** students to make sense of the mathematics and to persevere in solving mathematical problems. As you provide prompts and questions, check to see if **STUDENTS** exhibited the following behaviors in solving mathematics problems and if **TEACHERS** facilitated these behaviors by providing cognitively demanding tasks and encouraging sense making for **ALL** students.

Mathematical Practice Standard	Task (Example)	Teacher: Actions/Responsibilities	Student: Actions/Responsibilities
<p>MAKES SENSE OF PROBLEMS AND PERSEVERES IN SOLVING THEM</p>	<p>Open-ended problem with no solution pathway evident.</p> <p>Non-routine problems with multiple solutions.</p>	<p>Teacher:</p> <ul style="list-style-type: none"> • Provides time and facilitates discussion in problem solutions. • Facilitates discourse in the classroom so that students UNDERSTAND the approaches of others. • Provides opportunities for students to explain themselves, the meaning of a problem, etc. • Provides opportunities for students to connect concepts to “their” world. • Provides students TIME to think and become “patient” problem solvers. • Facilitates and encourages students to check their answers using different methods (not calculators). • Provides problems that focus on relationships and are “generalizable”. 	<p>Students:</p> <ul style="list-style-type: none"> • Are actively engaged in solving problems & thinking is visible (i.e., DOING MATHEMATICS vs. FOLLOWING STEPS OR PROCEDURES). • Are analyzing givens, constraints, relationships, and goals (NOT the teacher). • Are discussing with one another, making conjectures, planning a solution pathway, not jumping into a solution attempt or guessing at the direction to take. • Relate current “situation” to concept or skill previously learned and check answers using different methods. • Continually ask self, does this make sense?
<p>Evidence & Comments:</p>			

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<p>REASONING ABSTRACTLY AND QUANTITATIVELY</p>	<p>Provide a context or situation for students that allows them to “abstract” the situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents.</p> <p>Tasks that allow for pausing during the manipulation process in order to probe into the referents for the symbols involved.</p>	<p>Teacher:</p> <ul style="list-style-type: none"> • Provides a range of representations of math problem situations and encourages various solutions. • Provides opportunities for students to make sense of quantities and their relationships in problem situations. • Provides problems that require flexible use of properties of operations and objects. • Emphasizes quantitative reasoning which entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them and/or rules; and knowing and flexibly using different properties of operations and objects. 	<p>Students:</p> <ul style="list-style-type: none"> • Use varied representations and approaches when solving problems. • Make sense of quantities and their relationships in problem situations. • Are <i>decontextualizing</i> (abstract a given situation and represent it symbolically and manipulate the representing symbols), and <i>contextualizing</i> (pause as needed during the manipulation process in order to probe into the referents for the symbols involved). • Use quantitative reasoning that entails creating a coherent representation of the problem at hand, considering the units involved, and attending to the meaning of quantities, NOT just how to compute them.
<p>Evidence and Comments:</p>			

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<p>CONSTRUCTING VIABLE ARGUMENTS AND CRITIQUING THE ARGUMENTS OF OTHERS</p>	<p>Tasks that allow students to analyze situations by breaking them into cases and then justify, defend/refute and communicate examples and counterexamples, etc. etc.</p>	<p>Teacher:</p> <ul style="list-style-type: none"> • Provides ALL students opportunities to understand and use stated assumptions, definitions, and previously established results in constructing arguments. • Provides ample time for students to make conjectures and build a logical progression of statements to explore the truth of their conjectures. • Provides opportunities for students to construct arguments and critique arguments of peers. • Facilitates and guides students in recognizing and using counterexamples. • Encourages and facilitates students justifying their conclusions, communicating, and responding to the arguments of others. • Asks useful questions to clarify and/or improve students' arguments. 	<p>Students:</p> <ul style="list-style-type: none"> • Make conjectures and explore the truth of their conjectures. • Recognize and use counterexamples. • Justify and defend ALL conclusions and communicates them to others. • Recognize and explain flaws in arguments. (After listening or reading arguments of others, they respond by deciding whether or not they make sense. They ask useful questions to improve arguments.) • <u>Elementary</u> Students: construct arguments using concrete referents such as objects, drawings, diagrams, actions. <u>Later</u>, students learn to determine the domains to which an argument applies.
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MODEL WITH MATHEMATICS	<p>Problem solving situations such as:</p> <p>Elementary: this might be as simple as writing an addition equation to describe a situation.</p> <p>Middle grades: a student might apply proportional reasoning to plan a school event or analyze a problem in the community.</p> <p>High School: a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another.</p>	<p>Teacher:</p> <ul style="list-style-type: none"> • Provides problem situations that apply to everyday life. • Provides rich tasks that focus on conceptual understanding, relationships, etc. 	<p>Students:</p> <ul style="list-style-type: none"> • Apply the mathematics they know to everyday life, society, and the workplace. • Write equations to describe situations. • Are comfortable in making assumptions and approximations to simplify complicated situations. • Analyze relationships to draw conclusions. • Improve their model if it has not served its purpose.
Evidence and Comments:			
FATTENDS TO PRECISION	<p>Elementary: students are solving problems and carefully formulating explanations to others.</p> <p>High School: students are examining claims and making explicit use of definitions.</p>	<p>Teacher:</p> <ul style="list-style-type: none"> • Facilitates, encourages and <u>expects</u> precision in communication. • Provides opportunities for students to explain and/or write their reasoning to others. 	<p>Students:</p> <ul style="list-style-type: none"> • Use and clarify mathematical definitions in discussions and in their own reasoning (orally and in writing). • Use, understand and state the meanings of symbols. • Express numerical answers with a degree of precision.
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APPROPRIATE TOOLS USED	<p>Elementary: students are provided tasks that require a variety of tools to solve.</p> <p>High School: tasks might include students analyzing graphs of functions and solutions generated using a graphing calculator to detect possible errors by using estimations and other mathematical knowledge.</p>	<p>Teacher:</p> <ul style="list-style-type: none"> • Provides a variety of tools and technology for students to explore to deepen their understanding of math concepts. • Provides problem solving tasks that require students to consider a variety of tools for solving. (Tools might include pencil/paper, concrete models, ruler, protractor, calculator, spreadsheet, computer algebra system, statistical package, or dynamic geometry software, etc.) 	<p>Students:</p> <ul style="list-style-type: none"> • Consider available tools when solving a mathematical problem. • Are familiar with a variety of mathematics tools and use them when appropriate to explore and deepen their understanding of concepts.
Evidence and Comments:			
LOOK FOR AND MAKE USE OF STRUCTURE	<p>Elementary: task might require students to notice that three and seven more is the same amount as seven and three more or they may sort a collection of shapes according to how many sides they shapes have. Later, students will see $7 \times 8 =$ the well remembered $7 \times 5 + 7 \times 3$, in preparation for the distributive property.</p> <p>High School: in the expression $x^2 + 9x + 14$, students see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems.</p>	<p>Teacher:</p> <ul style="list-style-type: none"> • Provides opportunities and time for students to explore patterns and relationships to solve problems. • Provides rich tasks and facilitates pattern seeking and understanding of relationships in numbers rather than following a set of steps and/or procedures. 	<p>Students:</p> <ul style="list-style-type: none"> • Look closely to discern patterns or structure. • Associate patterns with properties of operations and their relationships. • Step back for an overview and can shift perspective. • See complicated things, such as algebraic expressions, as single objects or as composed of several objects. (Younger children decompose and compose numbers.)

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<p>LOOK FOR AND EXPRESS REGULARITY IN REPEATED REASONING</p>	<p>Upper Elementary: solving problems and noticing that when dividing 25 by 11 they are repeating the same calculations over and over again, and conclude they have a repeating decimal.</p> <p>Middle School: students might abstract the equation $(y-2)/=3$ by paying attention to the calculation of slope as they repeatedly check whether the points are on the line through (1,2) with a slope of 3.</p> <p>High School: Tasks that allow High School students to notice regularity in the way terms cancel when expanding $(x-1)(x+1)(x^2+1)$ and $(x-1)(x^3+x^2+x+1)$ which might lead to the general formula for the sum of a geometric series.</p>	<p>Teacher:</p> <ul style="list-style-type: none"> • Provides problem situations that allow students to explore regularity and repeated reasoning. • Provides rich tasks that encourage students to use repeated reasoning to form generalizations and provides opportunities for students to communicate these generalizations. 	<p>Students:</p> <ul style="list-style-type: none"> • Notice if calculations are repeated and look for both general methods and shortcuts. • Pay attention to regularity and use to solve problems. • Use regularity and use this to lead to a general formula and generalizations. • Maintain oversight of the process of solving a problem while attending to details and continually evaluates the reasonableness of immediate results.
Evidence and Comments:			

