High School Aspects of Rigor Guidance Document

Rigor refers to deep, authentic command of mathematical concepts, not making math harder or introducing topics at earlier grades. To help students meet the standards, educators need to pursue, with equal intensity, three aspects of rigor in the major work of each grade: conceptual understanding, procedural skills and fluency, and application.

Each Aspect of Rigor is listed below, with an explanation of what it is and guiding questions to help you understand what to look for in the materials. Two things to keep in mind:

(1) The three aspects of rigor are not always separate in materials. (Conceptual understanding and fluency go hand in hand; fluency can be practiced in the context of applications; and brief applications can build conceptual understanding.)

(2) Nor are the three aspects of rigor always together in materials. (Conceptual understanding must be and purposely taught rather than expecting student to infer conceptual understanding through the teaching of procedures.)

Aspect of Rigor	What it is:	Guidance:
Conceptual Understanding	Conceptual understanding refers to an integrated and functional grasp of the mathematical ideas. These may be ideas about shape and space, measure, pattern, function, uncertainty, or change. Students see the connections among concepts and procedures and can give arguments to explain why some facts are consequences of others. Students demonstrate deep conceptual understanding of core math concepts by applying them to new situations as well as writing and speaking about their understanding.	Are cluster(s) or standard(s) from the grade-level that specifically relate to conceptual understanding (look at it throughout the whole grade-level) developing conceptual understanding? Are math practices (look at it throughout the whole grade-level) developing conceptual understanding? Is conceptual understanding developed thoroughly where the standards set explicit expectations for understanding or interpreting? Do the instructional materials provide opportunities for students to independently demonstrate conceptual understanding throughout the series? Do the materials feature opportunities to identify correspondences across mathematical representations? Example, are students provided with opportunities to appreciate the use of a geometric model when exploring a number pattern or the use of ratios when analyzing a probability problem. Materials should amply feature high-quality conceptual problems and questions. This

		includes brief conceptual problems with low computational difficulty (e.g., 'What is the maximum value of the function $f(t) = 5 - t^2$?'); brief conceptual questions (e.g., 'Is $\sqrt{2}$ a polynomial? How about $\frac{1}{2}(x + \sqrt{2}) + \frac{1}{2}(-x + \sqrt{2})$?); and problems that involve identifying correspondences across different mathematical representations of quantitative relationships. Classroom discussion about such problems can offer opportunities to engage in mathematical practices such as constructing and critiquing arguments (MP.3). In the materials, conceptual understanding is attended to most thoroughly in those places in the content standards where explicit expectations are set for understanding or interpreting. Such problems and activities center on fine-grained mathematical concepts, such as the correspondence between an equation and its graph, solving equations as a process of answering a question, analyzing a nonlinear equation $f(x) = g(x)$ by graphing f and g on a single set of axes, etc. Conceptual understanding of key mathematical concepts is thus distinct from applications or fluency work, and these three aspects of rigor must be balanced as indicated in the Standards.
Procedural Skill	Procedural fluency refers to knowledge of procedures, knowledge of when and how to use them appropriately. Procedural fluency also refers to skill in performing flexibly, accurately, and efficiently such procedures as constructing shapes, measuring space, computing probabilities, and describing data. Students also need to know reasonably efficient and accurate ways to add, subtract, multiply, and divide multi-digit numbers, both mentally and with pencil and paper. Students need to see that procedures can be developed	Are the cluster(s) or standard(s) from the course that specifically relate to procedural skill developing procedural skill? Is instructional time given for students to support conceptual understanding and proficiency in the mathematical practices and to practice fluency in standard computational algorithms that is based on their understanding of properties, operations, and the base-ten number system? Is sufficient practice with algebraic operations provided so as to make realistic the attainment of the Standards as a whole; for example, fluency in algebra can help students get past the need to manage computational details so that they can observe structure (MP.7) and express regularity in repeated reasoning (MP.8).

	that will solve entire classes of problems, not just individual problems.	Are manipulatives and concrete representations connected to the written and symbolic methods to which they refer? Are methods and algorithms general and based on principles of mathematics, not mnemonics or tricks.
Applications of Mathematics	The standards call for students to use math in situations that require mathematical knowledge. Correctly applying mathematical knowledge depends on students having a solid conceptual understanding and procedural fluency. To engage in application: ● Students need opportunities to apply mathematical knowledge and/or skills in a real-world context. ●Materials should promote activities that call for the use of mathematics flexibly in a variety of contexts in both routine and non-routine problems. ● Students are given opportunities to use math to make meaning of and access content.	Are there a variety of single- and multi-step contextual problems, including non-routine problems that develop the mathematics of the grade? Do the problems attend thoroughly to the content standards where expectations for multi-step and real-world problems are explicit? Do the materials include problems in which students must make their own assumptions or simplifications in order to model a situation mathematically? Materials should include an ample number of contextual problems that develop the mathematics of the course, afford opportunities for practice, and engage students in problem solving. Applications take the form of problems to be worked on individually as well as classroom activities centered on application scenarios. Materials attend thoroughly to those places in the content standards where expectations for multi-step and real-world problems are explicit. Students learn to use the content knowledge and skills specified in the content standards in applications, with particular stress on applying widely applicable work. Problems and activities show a sensible tradeoff between the sophistication of the problem and the difficulty or newness of the content knowledge the student is expected to bring to bear.

Resources:

High School Publishers' Criteria for the Common Core State Standards for Mathematics, corestandards.org

High School Math Evidence Guides Combined, edreports.org

http://www.corestandards.org/other-resources/key-shifts-in-mathematics/

Adding it up

Principle to Actions