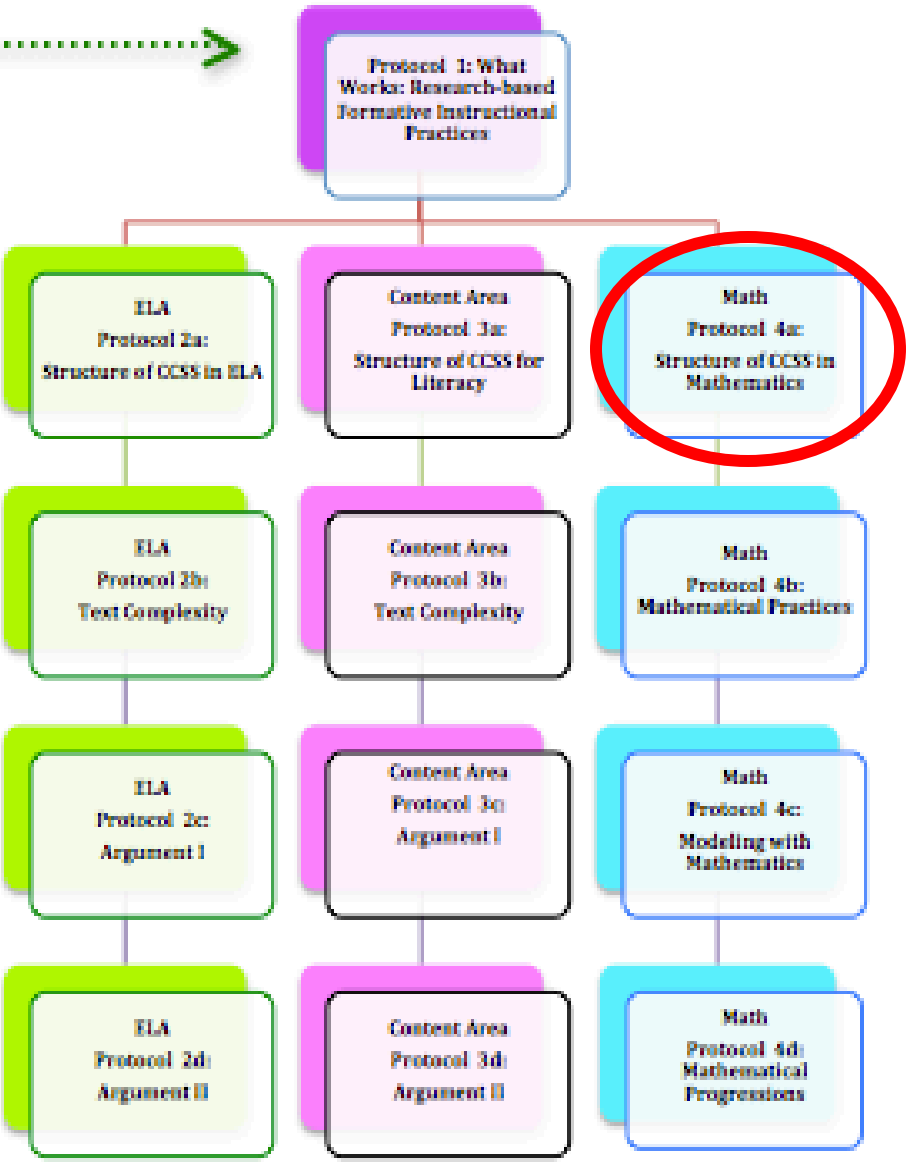
CCR High School Mathematics Protocol 4a

Structure of Common Core State Standards for High School Mathematics

College and Career Readiness: Tools for Schools

Secondary Sequence

Overview for Administrators:
Supporting Instructional Leadership with Job Embedded Professional Development



Continuous Support from Complex and State; Feedback Loop from Schools for Mid-Course Adjustments

Formative Instructional Practices

Where am I going?

How do we make learning targets clear to students so that they have the same understanding of quality as teachers do?

Where am I now?

How does feedback allow students to self assess and set goals?

How do I close the gap?

What opportunities allow students to close the learning gap?

Desired Outcomes

- Understand the structure and design of the CCSS in High School Mathematics

- Discuss the implications for instruction

All Means All

- The Common Core State Standards articulate rigorous expectations to prepare all students to be college and career ready, including English language learners and Special Education Students.
- These students likely will require additional instructional support.
- English Language Proficiency Standards (ELP) for ELL students are aligned to the CCSS.

Common Core: Mathematics Standards

Standards for Mathematical Practice

And

Content

Standards for Mathematical Practices (K-12)
Key for Identifying the Components

Standard Title

( ) Narrative Description

Turn to Standards for Mathematical Practices (Page 6)

Standards for Mathematical Practice

Follow along with the *Standards for Mathematical Practice* document – Practice 1 (page 6)

- Underline the Standard Title
- Bracket the Narrative Description

Mathematics | Standards for Mathematical Practice

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council's report *Adding It Up*: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy).

1 Make sense of problems and persevere in solving them.

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

2 Reason abstractly and quantitatively.

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given 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—and the ability to *contextualize*, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning 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 knowing and flexibly using different properties of operations and objects.

3 Construct viable arguments and critique the reasoning of others.

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions,

Underline: Standard title

Bracket: Narrative Description

Standards for Mathematical Practice

Review the Standards for Mathematical Practice document. Complete the process for Practices two through eight (page 6 – 8)

- Underline the Standard Title
- Bracket the Narrative Description

Components: High School Standards for Mathematical Content

Conceptual Categories: provide a coherent view of high school mathematics

Introduction: provide important contextual information and calls out and describes critical areas of focus

Domains: larger groups of related standards

Cluster Headings: overview and quick summary of the mathematical ideas within a domain

Content Standards: define what students should understand and be able to do

Standards for Mathematical Content (High School)
Key for Identifying the Components

Conceptual Category

Introduction

Domain

Cluster Heading

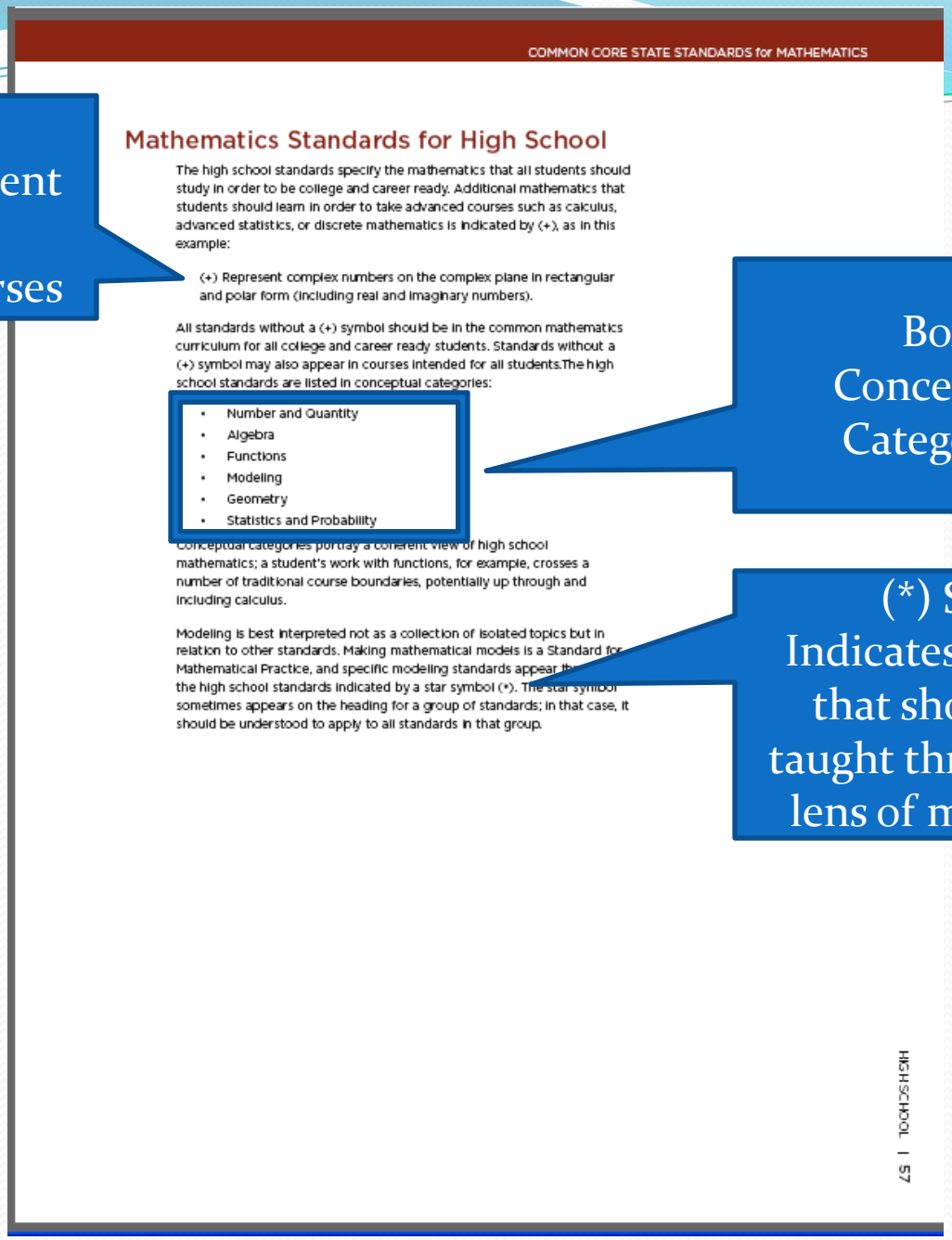
Content Standard

Mathematics Standards for High School

On page 57:

- Box the Conceptual Categories
- Highlight the second sentence in the first paragraph (description of the plus symbol (+))
- Highlight the first sentence of the last paragraph (description of the star symbol (*))

(+) Plus
Indicates content needed for advanced courses



COMMON CORE STATE STANDARDS for MATHEMATICS

Mathematics Standards for High School

The high school standards specify the mathematics that all students should study in order to be college and career ready. Additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics is indicated by (+), as in this example:

(+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers).

All standards without a (+) symbol should be in the common mathematics curriculum for all college and career ready students. Standards without a (+) symbol may also appear in courses intended for all students.The high school standards are listed in conceptual categories:

- Number and Quantity
- Algebra
- Functions
- Modeling
- Geometry
- Statistics and Probability

Conceptual categories portray a coherent view of high school mathematics; a student's work with functions, for example, crosses a number of traditional course boundaries, potentially up through and including calculus.

Modeling is best interpreted not as a collection of isolated topics but in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear th... the high school standards indicated by a star symbol (*). The star symbol sometimes appears on the heading for a group of standards; in that case, it should be understood to apply to all standards in that group.

HIGH SCHOOL | 57

Box:
Conceptual Categories

(*) Star
Indicates content that should be taught through the lens of modeling

Conceptual Categories

- There are six conceptual categories
  - Number and Quantity
  - Algebra
  - Functions
  - Modeling*
  - Geometry
  - Statistics and Probability
- Modeling* is best interpreted not as a collection of isolated topics but in relation to other standards.
  - The star symbol (*) appears throughout the high school standards to indicate making mathematical models

Mathematics | High School—Functions

Functions describe situations where one quantity dete… the return on $10,000 invested at an annualized percentage rate of 4.25% is a function of the length of time the money is invested. Because we continually make theories about dependencies between quantities in nature and society, functions are important tools in the construction of mathematical models.

In school mathematics, functions usually have numerical inputs and outputs and are often defined by an algebraic expression. For example, the time in hours it takes for a car to drive 100 miles is a function of the car's speed in miles per hour, v; the rule $T(v) = 100/v$ expresses this relationship algebraically and defines a function whose name is T.

The set of inputs to a function is called its domain. We often infer the domain to be all inputs for which the expression defining a function has a value, or for which the function makes sense in a given context.

A function can be described in various ways, such as by a graph (e.g., the trace of a seismograph); by a verbal rule, as in, "I'll give you a state, you give me the capital city;" by an algebraic expression like $f(x) = a + bx$; or by a recursive rule. The graph of a function is often a useful way of visualizing the relationship of the function models, and manipulating a mathematical expression for a function can throw light on the function's properties.

Functions presented as expressions can model many important phenomena. Two important families of functions characterized by laws of growth are linear functions, which grow at a constant rate, and exponential functions, which grow at a constant percent rate. Linear functions with a constant term of zero describe proportional relationships.

A graphing utility or a computer algebra system can be used to experiment with properties of these functions and their graphs and to build computational models of functions, including recursively defined functions.

Connections to Expressions, Equations, Modeling, and Coordinates.

Determining an output value for a particular input involves evaluating an expression; finding inputs that yield a given output involves solving an equation. Questions about when two functions have the same value for the same input lead to equations, whose solutions can be visualized from the intersection of their graphs. Because functions describe relationships between quantities, they are frequently used in modeling. Sometimes functions are defined by a recursive process, which can be displayed effectively using a spreadsheet or other technology.

Box: Conceptual Category

Bracket: Introduction

Standards for Mathematical Content (High School) Key for Identifying the Components

Select a different Conceptual Category

Number and Quantity: Pg. 58

Algebra: Pg . 62

Modeling: Pg. 72

Geometry: Pg. 74

Statistics and Probability: Pg. 79

- Box the Conceptual Category
- Bracket the Introduction

Modeling Standards in Algebra

- Identify all the standards with a star symbol within the Conceptual Category of Algebra

Modeling Standards in Algebra

Did you find all of the modeling standards in the conceptual category of Algebra?

At your table, discuss:

- Where did you find these modeling standards ?

  (. . . in the conceptual category level, the domain level, the cluster level, or at the standard level)
- What are the implications for planning for instruction?

Box: Conceptual Category

Circle: Domains

Underline: Cluster Headings

Functions Overview

Interpreting Functions

- Understand the concept of a function and use function notation
- Interpret functions that arise in applications in terms of the context
- Analyze functions using different representations

Building Functions

- Build a function that models a relationship between two quantities
- Build new functions from existing functions

Linear, Quadratic, and Exponential Models

- Construct and compare linear and exponential models and solve problems
- Interpret expressions for functions in terms of the situation they model

Trigonometric Functions

- Extend the domain of trigonometric functions using the unit circle
- Model periodic phenomena with trigonometric functions
- Prove and apply trigonometric identities

Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Circle: Domain

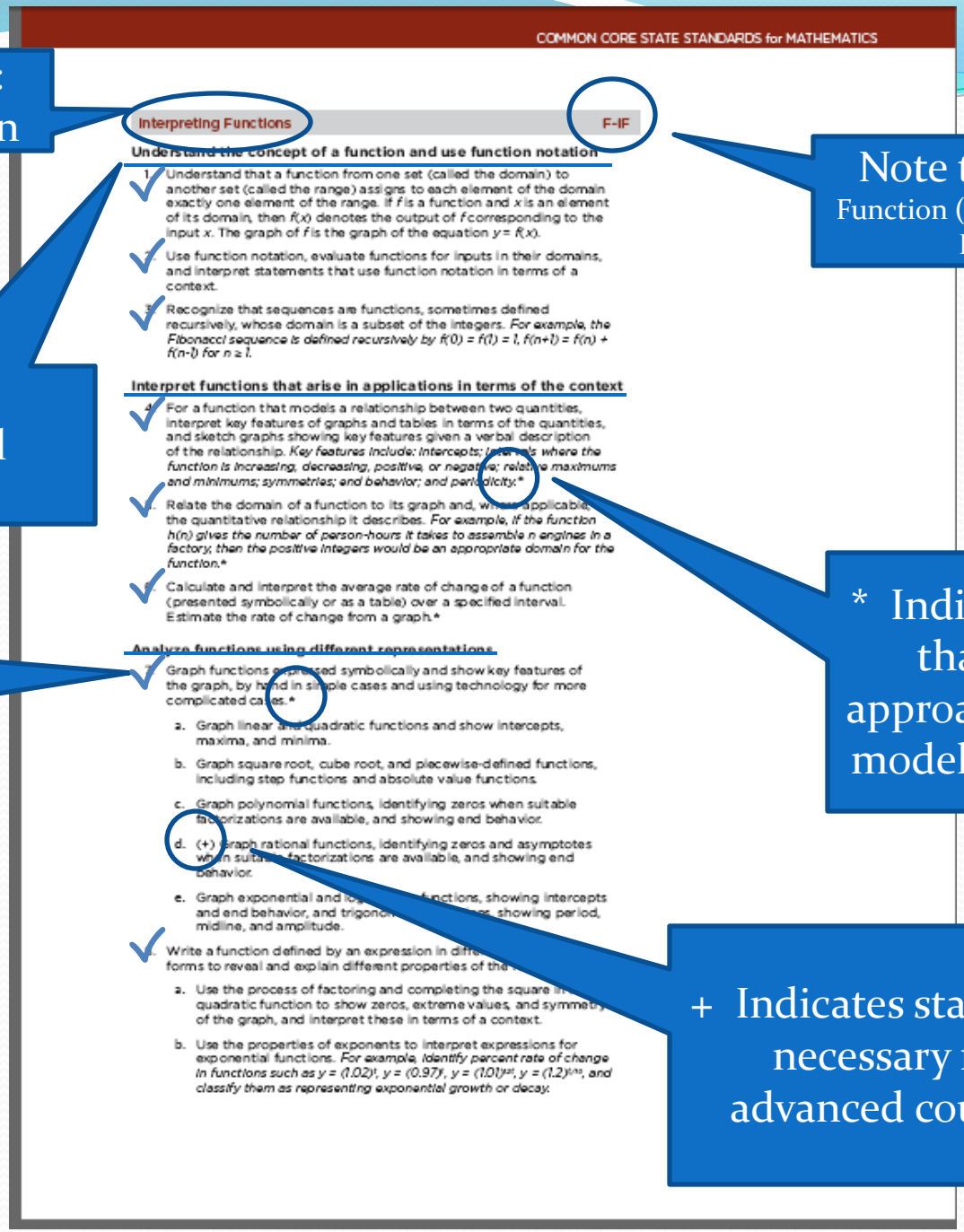
Underline: Conceptual Categories

Check mark: Standard

Note the code: F-IF
Function (Conceptual Category)
IF (Domain)

* Indicates standards that should be approached through a modeling perspective

\+ Indicates standards necessary for advanced courses



COMMON CORE STATE STANDARDS for MATHEMATICS

Interpreting Functions F-IF

Understand the concept of a function and use function notation

1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.*

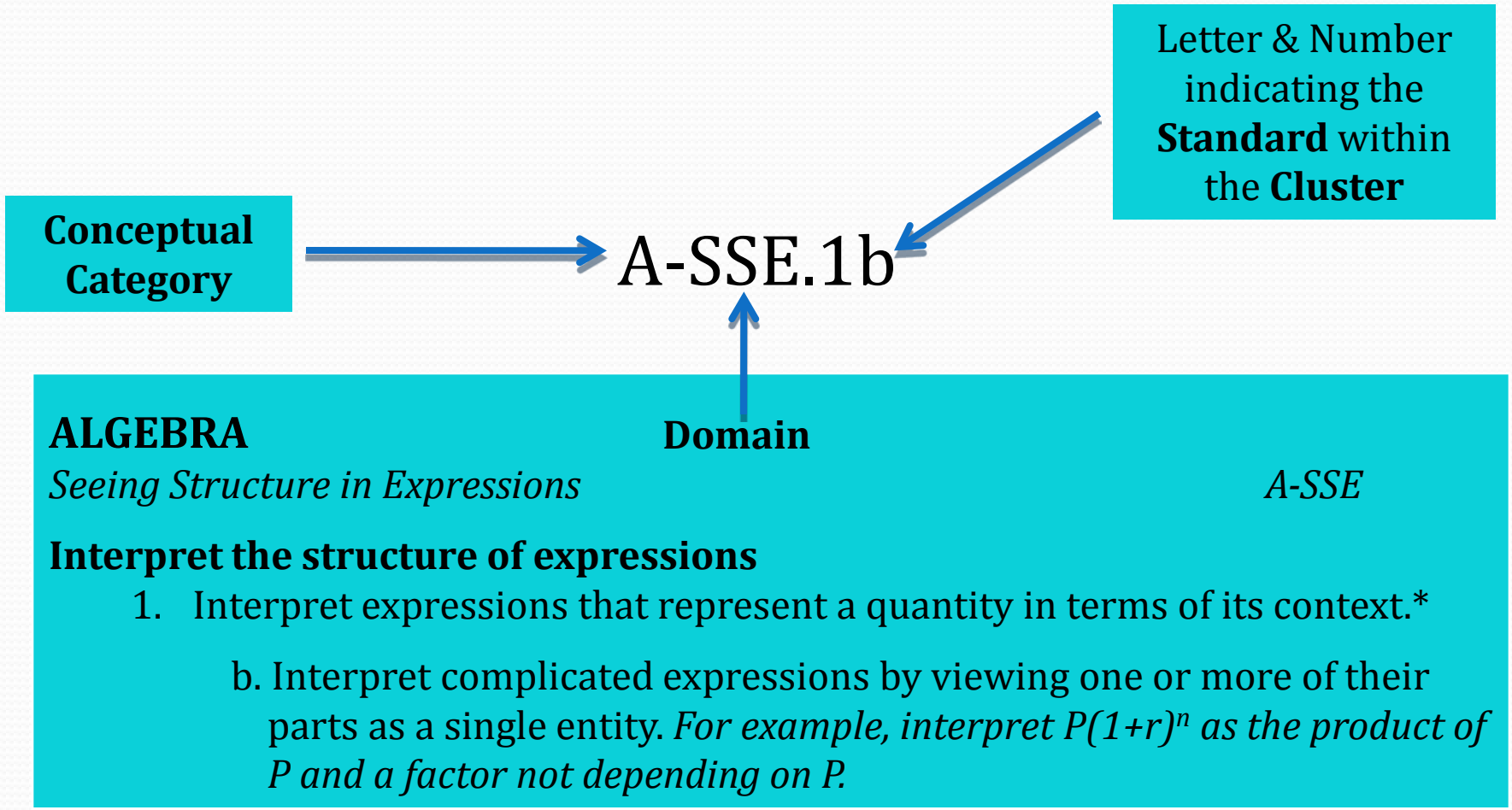
Interpret functions that arise in applications in terms of the context

4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.**
5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.**
6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
   a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
   b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
   c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
   d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
   e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
   a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
   b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay.*

How to read a Common Core High School Mathematics Standard



How to read a Common Core High School PATHWAYS Mathematics Standard

Indicates: Content needed for advanced courses

Numbers indicating the Standards within the Cluster Heading

(+)N.CN.4

Number & Quantity

The Complex Number System

Represent complex numbers and their operations on the complex plane.

4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a give complex number represent the same number.

5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. *For example, $(-1 + \sqrt{3}\, i)^3 = 8$ because $(-1 + \sqrt{3}\, i)$ has modulus 2 and argument 120^0.*

6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

+ Additional Mathematics

- Additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics are indicated by a plus symbol (+).
- All standards without a (+) symbol should be in the common curriculum for all college and career ready students.
- Standards with a (+) symbol may also appear in courses intended for all students.

Standards for Advanced Courses
in the Conceptual Category of Algebra

- Identify all the standards with a plus symbol within the Conceptual Category of Algebra

Standards for Advanced Courses in Algebra

Did you find all of the standards for advanced mathematics in the conceptual category of Algebra?

At your table, discuss:

- Where did you find these advanced standards?
- What are the implications for planning for instruction?

RESOURCES

Common Core State Standards

http://www.corestandards.org/the-standards

Hawaii Standards Toolkit

http://wetserver.net/hcpsv3_staging/cc/common-core.jsp

Unpacked Math Standards (Arizona):

http://www.azed.gov/standards-practices/mathematics-standards/

HIDOE Edmodo online community for High School:

www.edmodo.com

(join "HIDOE High School Math". Use code: mcbkv6)

PDE³ Survey Reminder: https://pde3.k12.hi.us

Survey

You are currently viewing - Race To The Top (RTTT)

Question: 1 Rate your satisfaction level on this protocol.

Rate your satisfaction level on this protocol.

- ○ Not at all satisfied
- ○ Slightly satisfied
- ○ Moderately satisfied
- ○ Very satisfied
- ○ Extremely satisfied

Question: 2 Rate the level of understanding learned or gained from this protocol

Rate the level of understanding learned or gained from this protocol

- ○ Not at all
- ○ A little
- ○ Somewhat
- ○ Quite a bit
- ○ A lot

Question: 3 Rate the level of impact this protocol will have on your practice. Not at all; A little; Somewhat; Quite a bit; A lot

Rate the level of impact this protocol will have on your practice.

- ○ Not at all
- ○ A little
- ○ Somewhat
- ○ Quite a bit
- ○ A lot

Question: 4 What other resources would be helpful?

What other resources would be helpful?

Feedback

Question: 5 Any other questions or comments about the material in this protocol.

Any other questions or comments about the material in this protocol.

Thank your for your feedback