

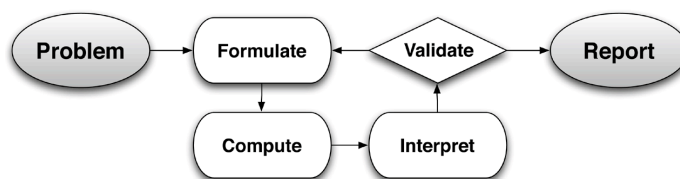
Common Core State Standards for High School Mathematics

The Common Core State Standards (CCSS) promote a conceptual and analytical approach to the study of mathematics. In the elementary and middle years, the CCSS encourage the development of algebraic concepts through students' understanding of arithmetic operations. Students apply their knowledge of place value, properties of operations, and the inverse relationships between operations (addition and subtraction; multiplication and division) to write and solve first arithmetic and then algebraic equations of varying complexities. In the late elementary years, students begin to manipulate parts of the expression and explore the meaning of an expression when it is rewritten in different forms. This early analytic focus helps students look more fully at equations and expressions so that they begin to see patterns in their structure.

Modeling

The CCSS place a specific emphasis on mathematical modeling, both in the Standards for Mathematical Practices and in the High School Content Standards. With this focus, the authors of the CCSS look to highlight the pervasive utility and applicability of mathematical concepts in real-world situations and in students' daily lives.

The CCSS presents a basic modeling cycle that involves a 6-step process: *(1) identifying variables in the situation and selecting those that represent essential features, (2) formulating a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables, (3) analyzing and performing operations on these relationships to draw conclusions, (4) interpreting the results of the mathematics in terms of the original situation, (5) validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable, (6) reporting on the conclusions and the reasoning behind them. Choices, assumptions, and approximations are present throughout this cycle.*¹



Algebra

By the end of Grade 8, students have synthesized their knowledge of operations, proportional relationships, and algebraic equations and have begun to formalize their understanding of linearity and linear equations.

The study of algebra in the high school years extends the conceptual and analytic approach of the elementary and middle years. It expands the focus of study from solving equation and applying formulae to include a structural analysis of expressions, equations, and inequalities. In the CCSS, the domain names and cluster descriptions are a telling indication of this analytic approach.

¹ Common Core State Standards for Mathematics, June 2010, p. 72

Seeing Structure in Expressions

- Interpret the structure of expressions
- Write expressions in equivalent forms to solve problems

Arithmetic with Polynomials and Rational Functions

- Perform arithmetic operations on polynomials
- Understand the relationship between zeros and factors of polynomials
- Use polynomial identities to solve problems
- Rewrite rational expressions

Creating Equations

- Create equations that describe numbers or relationships

Reasoning with Equations and Inequalities

- Understand solving equations as a process of reasoning and explain the reasoning
- Solve equations and inequalities in one variable
- Solve systems of equations
- Represent and solve equations and inequalities graphically

High School students expand their analysis of linear expressions from Grade 8 to exponential and quadratic expressions, and then to polynomial and rational expressions. They use their understanding of the structure of expressions and the meaning of each term within expressions to rewrite expressions in equivalent forms to solve problems. Students draw from their understanding of arithmetic operations with numbers to solve algebraic equations and inequalities.

High School students write equations and inequalities in one or more variables to represent relationships. They interpret solutions to equations or inequalities as viable or non-viable options given the constraints in a modeling context. Students develop fluency using expressions and equations, from linear, exponential, quadratic to polynomial, and rational, and simple radical. They represent expressions and equations graphically, starting with linear, exponential, and quadratic equations and progressing to polynomial, rational, and radical equations.

High School students come to understand the process of solving equations as one of reasoning. They construct viable arguments to justify a solution method. In advanced algebra courses, students explain the presence and meaning of extraneous solutions.

Number and Quantity

From the elementary through middle years, students expand their notion of number, from counting to whole numbers, then to fractions, including decimal fractions, and then to negative whole numbers and fractions to form the rational numbers, and finally, by the end of middle years, to irrational numbers to form the real numbers. In high school, students deepen their understanding of the real number system and then come to know the complex number system.

The domains and clusters in this conceptual category are shown below.

The Real Number System

- Extend the properties of exponents to rational exponents
- Use properties of rational and irrational numbers

Quantities

- Reason quantitatively and use units to solve problems

The Complex Number System

- Perform arithmetic operations with complex numbers
- Represent complex numbers and their operations on the complex plane
- Use complex numbers in polynomial identities and equations

Vector and Matrix Quantities

- Represent and model with vector quantities
- Perform operations on vectors
- Perform operations on matrices and use matrices in applications

As students encounter these expanding notions of number, they develop a greater understanding of the meanings of addition, subtraction, multiplication, and division while recognizing that the properties of these operations remain constant. Students also realize that the new meanings of operations are

consistent with their previous meanings.

Functions

Students began a formal study of functions in Grade 8 where they explored functions presented in different ways (algebraically, numerically in tables, and graphically) and compared the properties of different functions presented in different ways. They described the functional relationship between two quantities and represent the relationship graphically.

The domains and clusters for functions are listed below.

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

Building on their knowledge of functions, high school students use function notation to express linear and exponential functions, and arithmetic and geometric sequences. They also compare properties of two (or more) functions, each represented algebraically, graphically, numerically using tables, or by verbal description and describe the common effect of each transformation across different types of functions. They analyze progressively more complex functions, from linear, exponential, and quadratic to logarithmic, rational, and radical functions.

A strong emphasis of the study of functions is its applicability to real-world situations and relationships. Students build functions that model real-world situations and/or relationships, using the functions they have studied, and they interpret the functions as they apply to these situations. More advanced study of functions includes trigonometric functions. Students start their study of trigonometry by connecting the functions to the unit circle. They model periodic phenomena with trigonometric functions. They also prove and apply simple trigonometric identities.

Geometry

In the middle years, students undertook an exploration of congruence and similarity through transformations. They verified the properties of transformations (reflections, translations, rotations, dilations) and described the effect of each on two-dimensional shapes using coordinates. Student explained that shapes are congruent or similar based on a sequence of transformations.

In high school geometry, students expand their experiences with transformations and engage in formal proofs of geometric theorems, using transformations in the plane as a foundation to prove congruence and similarity. From this foundation, students look to define trigonometric ratios and apply these concepts to solve problems involving right triangles.

High school students engage in a formal study of circles, applying theorems about circles and solving problems related to parts of circles or properties of circles. Through the study of equations that describe geometric shapes, students connect algebraic manipulation of equations or formulae to geometric properties and structures. As with other mathematical concepts, students investigate modeling real-world situations or relationships by applying geometric concepts.

Congruence

- Experiment with transformations in the plane
- Understand congruence in terms of rigid motions
- Prove geometric theorems
- Make geometric constructions

Similarity, Right Triangles, and Trigonometry

- Understand similarity in terms of similarity transformations
- Prove theorems involving similarity
- Define trigonometric ratios and solve problems involving right triangles
- Apply trigonometry to general triangles

Circles

- Understand and apply theorems about circles

- Find arc lengths and areas of sectors of circles

Expressing Geometric Properties with Equations

- Translate between the geometric description and the equation for a conic section
- Use coordinates to prove simple geometric theorems algebraically

Geometric Measurement and Dimension

- Explain volume formulas and use them to solve problems
- Visualize relationships between two-dimensional and three-dimensional objects

Modeling with Geometry

- Apply geometric concepts in modeling situations