Ohio State Common Core Standards for Mathematics
K – 12 TECHNOLOGY FOCUS

INTRODUCTORY PRINCIPLES

Use appropriate tools strategically.
Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a **spreadsheet**, a **computer** algebra system, a statistical package, or dynamic geometry **software**. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a **graphing calculator**. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that **technology** can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as **digital** content located on a **website**, and use them to pose or solve problems. They are able to use **technological** tools to explore and deepen their understanding of concepts.

Connecting the Standards for Mathematical Practice to the Standards for Mathematical Content
The Standards for Mathematical Practice describe ways in which developing student practitioners of the discipline of mathematics increasingly ought to engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle and high school years. Designers of curricula, assessments, and professional development should all attend to the need to connect the mathematical practices to mathematical content in mathematics instruction. The Standards for Mathematical Content are a balanced combination of procedure and understanding. Expectations that begin with the word “understand” are often especially good opportunities to connect the practices to the content. Students who lack understanding of a topic may rely on procedures too heavily. Without a flexible base from which to work, they may be less likely to consider analogous problems, represent problems coherently, justify conclusions, apply the mathematics to practical situations, use **technology** mindfully to work with the mathematics, explain the mathematics accurately to other students, step back for an overview, or deviate from a known procedure to find a shortcut. In short, a lack of understanding effectively prevents a student from engaging in the mathematical practices.

GRADE 7

Geometry 7.G

2. Draw (freehand, with ruler and protractor, and with **technology**) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

Grade 8

Geometry

• Understand congruence and similarity using physical models, transparencies, or geometry **software**.

Expressions and equations 8.ee

4. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by **technology**. Understand the connections between proportional relationships, lines, and linear equations.

Geometry 8.G

Understand congruence and similarity using physical models, transparencies, or geometry **software**.

High School

ALGEBRA

Number and Quantity Special Note:
Calculators, **spreadsheet**s, and **computer** algebra systems can provide ways for students to become better acquainted with these new number systems and their notation. They can be used to generate data for numerical experiments, to help understand the workings of matrix, vector, and complex number algebra, and to experiment with non-integer exponents.

Algebra Expressions Special Note:
A **spreadsheet** or a **computer** algebra system (CAS) can be used to experiment with algebraic expressions, perform complicated algebraic manipulations, and understand how algebraic manipulations behave.

Seeing Structure in expressions a-SSe
Rewrite rational expressions

6. Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a **computer** algebra system.

Reasoning with equations and Inequalities a-rel
Understand solving equations as a process of reasoning and explain the reasoning

9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using **technology** for matrices of dimension 3 × 3 or greater).

Represent and solve equations and inequalities graphically

11. Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using **technology** to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

FUNCTIONS

Functions Special Note:
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. 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**.

Interpreting functions f-If
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.

Building functions f-Bf

Build new functions from existing functions

3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using **technology**. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

Linear and exponential models f-Le

Construct and compare linear and exponential models and solve problems

4. For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using **technology**.

trigonometric functions f-tf

Extend the domain of trigonometric functions using the unit circle

7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using **technology**, and interpret them in terms of the context.

GEOMETRY

Modeling Special Note:

When making mathematical models, **technology** is valuable for varying assumptions, exploring consequences, and comparing predictions with data. The models devised depend on a number of factors: How precise an answer do we want or need? What aspects of the situation do we most need to understand, control, or optimize? What resources of time and tools do we have? The range of models that we can create and analyze is also constrained by the limitations of our mathematical, statistical, and technical skills, and our ability to recognize significant variables and relationships among them. Diagrams of various kinds, **spreadsheet**s and other **technology**, and algebra are powerful tools for understanding and solving problems drawn from different types of real-world situations.

Graphing utilities, **spreadsheet**s, **computer** algebra systems, and dynamic geometry **software** are powerful tools that can be used to model purely mathematical phenomena (e.g., the behavior of polynomials) as well as physical phenomena.

Geometry Special Note:

An understanding of the attributes and relationships of geometric objects can be applied in diverse contexts—interpreting a schematic drawing, estimating the amount of wood needed to frame a sloping roof, rendering **computer** graphics, or designing a sewing pattern for the most efficient use of material. Dynamic geometry environments provide students with experimental and modeling tools that allow them to investigate geometric phenomena in much the same way as **computer** algebra systems allow them to experiment with algebraic phenomena.

Geometry overview Congruence G-Co

Experiment with transformations in the plane

2. Represent transformations in the plane using, e.g., transparencies and geometry **software**; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry **software**. Specify a sequence of transformations that will carry a given figure onto another.

Make geometric constructions

12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric **software**, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

STATISTICS

Statistics and Probability Special Note:

Technology plays an important role in statistics and probability by making it possible to generate plots, regression functions, and correlation coefficients, and to simulate many possible outcomes in a short amount of time. Connections to Functions and Modeling. Functions may be used to describe data; if the data suggest a linear relationship, the relationship can be modeled with a regression line, and its strength and direction can be expressed through a correlation coefficient.

Interpreting Categorical and Quantitative data S-Id

Summarize, represent, and interpret data on a single count or measurement variable

4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, **spreadsheet**s, and tables to estimate areas under the normal curve.

Interpret linear models

8. Compute (using **technology**) and interpret the correlation coefficient of a linear fit.