Nebraska Mathematics

Grades 9, 10, 11, 12

Adopted 2022

Nebraska Mathematical Processes

1. **Make sense of problems and persevere in solving them.** MP.1
2. **Reason quantitatively and abstractly and consider the reasoning of others.** MP.2
3. **Create and use representations to organize, record, and communicate mathematical ideas.** MP.3
4. **Analyze mathematical relationships to connect mathematical ideas.** MP.4
5. **Explain and justify mathematical ideas using precise mathematical language in written or oral communication.** MP.5

High School

Number

1. Solve problems and reason with number concepts using multiple representations, make connections within math and across disciplines, and communicate their ideas. HS.CS.1
    1. Estimation and Technology: Students will use estimation strategies and technology to reason, to solve problems, and to make connections within mathematics and across disciplines. HS.N.1
        a. Select, apply, and explain the method of computation when problem solving using real numbers (e.g., models, mental computation, paper-pencil, technology). HS.N.1.A
        b. Determine if the context of a problem calls for an approximation or an exact value. HS.N.1.B
        c. Determine the rounding convention to be used based on the context of a problem. HS.N.1.C
        d. Estimate a value using the concept of betweenness by bounding above and below (e.g., since log(10) = 1 and log(1,000) = 3 we know log(500) is between 1 and 3). HS.N.1.D
        e. Determine the tolerance interval and percent of error in measurement. HS.N.1.E
        f. Convert equivalent rates (e.g., miles per hour to feet per second). HS.N.1.F
        g. Determine whether extremely large or extremely small quantities can be reasonably represented by a calculator or graphing utility. HS.N.1.G
        h. Use scientific notation to appropriately represent large and small quantities. HS.N.1.H
    2. Sets and Operations: Students will use number sets and operations to reason and to solve problems. HS.N.2
        a. Extend the properties of exponents to rational numbers. HS.N.2.A
        b. Use properties of rational and irrational numbers. HS.N.2.B
        c. Demonstrate, represent, and show relationships among the subsets of real numbers and the complex number system. HS.N.2.C
        d. Compute with subsets of the complex number system including imaginary, rational, irrational, integers, whole, and natural numbers. HS.N.2.D
    3. Interpretation and Sense Making: Students will reason abstractly and quantitatively using units to solve problems and interpret results in context. HS.N.3
        a. Understand roundoff error and why roundoff error accumulates when rounding occurs prior to the last step in a computation. HS.N.3.A
        b. Use estimation methods to check the reasonableness of real number computations and decide if the problem calls for an approximation (including appropriate rounding) or an exact number. HS.N.3.B

c. Use units to assess the validity of an answer in the context of a problem. HS.N.3.C

d. Communicate the meaning of an answer in the context of a problem. HS.N.3.D

Algebra

2. Solve problems and reason with algebra using multiple representations, make connections within math and across disciplines, and communicate their ideas. HS.CS.2

    1. Algebraic Relationships: Students will demonstrate and represent relationships with functions. HS.A.1

        a. Demonstrate that functions are a well mapped subdomain of relations. HS.A.1.A

        b. Analyze a relation to determine if it is a function given mapping diagrams, function notation (e.g., f(x)=x2), a table, or a graph. HS.A.1.B

        c. Classify a function given its mapping diagram, function notation, table, or graph as a linear, quadratic, absolute value, exponential, or other function. HS.A.1.C

        d. Analyze a function's domain and range to determine if it is one-to-one and has an inverse function both algebraically and graphically. HS.A.1.D

        e. Define, interpret, and analyze linear, quadratic, absolute value, and exponential functions using the points of interest of the functions and graphing technology. HS.A.1.E

        f. Identify, analyze, and apply transformations of existing functions (including translation and dilation). HS.A.1.F

        g. Interpret logarithmic equations as exponential equations. HS.A.1.G

        h. Describe arithmetic sequences using tables of values and functions in explicit and recursive forms. HS.A.1.H

        i. Describe geometric sequences using tables of values and functions in explicit and recursive forms. HS.A.1.I

    2. Algebraic Processes: Students will apply the operational properties when evaluating rational expressions and solving linear and quadratic equations, and inequalities. HS.A.2

        a. Analyze and explain the properties used in solving equations, inequalities, systems of linear equations, systems of linear inequalities, and literal equations. HS.A.2.A

        b. Generate expressions in equivalent forms by using algebraic properties to make different characteristics or features visible. HS.A.2.B

        c. Analyze equations and inequalities to determine and apply efficient methods to solve and use appropriate technology as needed. HS.A.2.C

        d. Calculate the slope (rate of change) of a line given coordinate points, a graph, or a table of values. HS.A.2.D

        e. Write and graph equations of functions (linear, absolute value, quadratic, and exponential) using the points of interest of the function. HS.A.2.E

        f. Given a line, write the equation of a line that is parallel or perpendicular to it. HS.A.2.F

g. Perform and explain operations such as addition, subtraction, multiplication, division, and factoring on polynomials. HS.A.2.G

h. Explain the connection between the factors of a polynomial and the zeros of a polynomial. HS.A.2.H

i. Combine functions by composition and perform operations on functions. HS.A.2.I

3. Applications: Students will solve authentic problems using nonlinear functions. HS.A.3

   a. Analyze and model authentic situations using various representations and appropriate technology. HS.A.3.A

   b. Identify, interpret, relate, and graph the factors, x-intercepts, roots, and zeros of polynomial functions using algebraic and graphing methods. HS.A.3.B

   c. Identify and predict appropriate solutions to equations given context and domain/range (e.g., extraneous solutions, imaginary solutions, no solution, infinitely many solutions). HS.A.3.C

Geometry

3. Solve problems and reason with geometry using multiple representations, make connections within math and across disciplines, and communicate their ideas. HS.CS.3
    1. Attributes: Students will identify and describe geometric attributes, apply properties and theorems, and create two- dimensional shapes. HS.G.1
        a. Demonstrate that two figures are similar or congruent by using a sequence of rigid motions and dilations that map a figure onto the other in problems both with and without coordinates. HS.G.1.A
        b. Describe symmetries of a figure in terms of rigid motions that map a figure onto itself and make inferences about symmetric figures (e.g., unknown side lengths or angle measures) in problems both with and without coordinates. HS.G.1.B
        c. Explain how the criteria for triangle congruence and similarity (ASA, SAS, AAS, and SSS congruence; AA similarity criterion) follow from the definition of congruence and similarity in terms of corresponding parts. HS.G.1.C
        d. Identify and apply right triangle relationships including converse of the Pythagorean Theorem. HS.G.1.D
        e. Apply side and angle relationships of special right triangles (30 degree-60 degree-90 degree and 45 degree-45 degree-90 degree) to solve geometric problems. HS.G.1.E
        f. Identify and apply right triangle relationships including sine, cosine, and tangent. HS.G.1.F
        g. Apply interior and exterior angle formulas for n-gons and apply to authentic situations. HS.G.1.G
        h. Compare/contrast the properties of quadrilaterals: parallelograms, rectangles, rhombi, squares, kites, trapezoids, and isosceles trapezoids. HS.G.1.H
        i. Use slope and the distance formula to determine the type of quadrilateral. HS.G.1.I
        j. Identify, describe, apply, and reason through properties of central angles, inscribed angles, angles formed by intersecting chords, secants, and/or tangents to find the measures of angles related to the circle, arc lengths, and areas of sectors. HS.G.1.J
    2. Attributes: Students will identify and describe geometric attributes, apply properties and theorems and create three-dimensional shapes. HS.G.2
        a. Convert between various units of volume (e.g., cubic feet to cubic yards). HS.G.2.A
        b. Apply the effect of a scale factor to determine the volume of similar three-dimensional shapes and solids. HS.G.2.B
        c. Determine surface area and volume of pyramids, as well as solids that are composites of pyramids, prisms, spheres, cylinders, and cones, using formulas

and appropriate units. HS.G.2.C

3. Coordinate Geometry and Transformations: Students will demonstrate and represent location, orientation, and relationships on the coordinate plane. HS.G.3
    a. Derive the midpoint formula using the concept of average and apply the midpoint formula to find coordinates. HS.G.3.A
    b. Find the images and preimages of transformations of a point, shape, or a relation on the coordinate plane. Transformations include the following and their compositions: reflections across horizontal and vertical lines and the lines y=x and y=-x, rotations about the origin of 90 degrees, dilations about the origin by any positive scale factor, and any translation. HS.G.3.B
    c. Find the equation of a circle given the radius and the center. HS.G.3.C
4. Logic and Proof: Students will use geometric definitions and theorems to reason abstractly and quantitatively. HS.G.4
    a. Know and use definitions to make deductions in mathematical argumentation (e.g., syllogism, detachment). HS.G.4.A
    b. Evaluate the validity of conditional statements, including biconditional statements (e.g., conditional, converse, contrapositive, inverse). HS.G.4.B
    c. Evaluate the validity of an argument communicated in different ways (e.g., a flow format, two- column, paragraph format). HS.G.4.C
    d. Use coordinate geometry to prove triangles are right, acute, obtuse, isosceles, equilateral, or scalene. HS.G.4.D
    e. Prove and apply geometric properties and theorems regarding triangles, congruence, and similarity using deductive reasoning. HS.G.4.E
    f. Prove and apply geometric theorems about quadrilaterals using deductive reasoning. HS.G.4.F

Data

4. Solve problems and reason with data/probability using multiple representations, make connections within math and across disciplines, and communicate their ideas. HS.CS.4
    1. Data Collection and Statistical Methods: Students will formulate statistical investigative questions, collect data, and organize data. HS.D.1
        a. Formulate multi-variable statistical investigative questions and determine how data can be collected and analyzed to provide an answer. HS.D.1.A
        b. Apply an appropriate data collection plan when collecting primary data for the statistical investigative question of interest. HS.D.1.B
        c. Use appropriate technology, including spreadsheet-based logic, to organize data for analysis. HS.D.1.C
        d. Distinguish between surveys, observational studies, and experiments. HS.D.1.D
        e. Understand what constitutes good practice in designing a sample survey, an experiment, and an observational study. HS.D.1.E
        f. Understand issues of bias and confounding variables in a study and their implications for interpretation. HS.D.1.F
    2. Analyze Data and Interpret Results: Students will represent and analyze the data and interpret the results. HS.D.2
        a. Identify appropriate ways to summarize and then represent the distribution of univariate data and bivariate data through the construction of histograms, dot plots, stem plots, box plots, cumulative relative frequency graphs, time plots, circle graphs, stacked bar graphs, and mosaic bar graphs by hand or with technology. HS.D.2.A
        b. Describe the shape, identify any outliers, and determine the spread of a data set. HS.D.2.B
        c. Select and determine the appropriate measure of center based on the shape of a distribution and/or the presence of outliers. HS.D.2.C
        d. Recognize when a data set can be reasonably said to be normally distributed and draw conclusions about the data from the associated normal distribution. HS.D.2.D
        e. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data and recognize possible associations and trends in the data. HS.D.2.E
        f. Represent data on two quantitative variables on a scatter plot and describe how the variables are related. HS.D.2.F
        g. Use technology to develop regression models for linear and non-linear data to predict unobserved outcomes. Interpret slope and y-intercept in the context of the problem. HS.D.2.G

h. Measure the strength of association using correlation coefficients for regression curves and interpret their meanings for the model. HS.D.2.H

i. Use residuals and residual plots to judge the quality of a regression model. HS.D.2.I

j. Recognize and explain when arguments based on data confuse correlation with causation. HS.D.2.J

k. Understand what constitutes statistical significance. Interpret statistical significance in the context of a situation and answer investigative questions appropriately. HS.D.2.K

l. Use probability as a tool for assessing risk and for informed decision making by interpreting P-values. HS.D.2.L

3. Probability: Students will interpret and apply concepts of probability. HS.D.3

a. Describe events as subsets of a sample space using characteristics of the outcomes or as unions, intersections, or complements of other events. HS.D.3.A

b. Explain independent versus dependent probability of an event. HS.D.3.B

c. Determine when order in counting matters and use permutations and combinations to compute probabilities of events accordingly. HS.D.3.C

d. Determine whether or not events are mutually exclusive (disjoint) and calculate their probabilities in either case. HS.D.3.D

e. Recognize and explain the concepts of conditional probability in everyday language and everyday situations. HS.D.3.E

High School Advanced Topics

Number

1. Solve problems and reason with number concepts using multiple representations, make connections within math and across disciplines, and communicate their ideas. HSA.CS.1
    1. Estimation and Technology: Students will use estimation strategies and technology to reason, to solve problems, and to make connections within mathematics and across disciplines. AT.N.1
        a. Use domain and range restrictions to apply an appropriate viewing window while using graphing technology. AT.N.1.A
        b. Compare and contrast radians and degrees as measures of angles and the reason graphing utilities tend to use radians as the default setting. AT.N.1.B
    2. Sets and Operations: Students will compare and contrast subsets and perform operations with subsets of the complex number system to reason and to solve problems. AT.N.2
        a. Perform arithmetic operations with complex numbers. AT.N.2.A
        b. Represent complex numbers and their operations in the complex plane. AT.N.2.B
        c. Use complex numbers in polynomial identities and equations. AT.N.2.C
        d. Represent quantities using bases other than decimal such as binary (base 2) or hexadecimal (base 16) and convert numbers to and from base 10. AT.N.2.D
        e. Explain modular arithmetic and its role in computer programming. AT.N.2.E
        f. Represent and model vector quantities. AT.N.2.F
        g. Perform operations on vectors. AT.N.2.G
        h. Perform operations on matrices and use matrices in applications. AT.N.2.H
    3. Interpretation and Sense Making: Students will reason abstractly and quantitatively using units to solve problems and interpret results in context. AT.N.3
        a. Use vectors to communicate the geometric relationships between complex numbers in the complex plane. AT.N.3.A

Algebra

2. Solve problems and reason with algebra using multiple representations, make connections within math and across disciplines, and communicate their ideas. HSA.CS.2

    1. Algebraic Relationships: Students will demonstrate and represent relationships with functions. AT.A.1

        a. Analyze and graph nonlinear functions (trigonometric, rational, higher-order polynomials, logarithmic, and piecewise) and relations (conic sections) using their points of interest and graphing technology. AT.A.1.A

        b. Use the unit circle to define the trigonometric functions on multiples of known angles (positive and negative multiples of 30 and 45 degrees or pi/6 and pi/4). AT.A.1.B

        c. Given a function, list the sequence of algebraic transformations that changes a parent function to the given function. AT.A.1.C

        d. Define the radian unit of measure and its relationship with degrees. AT.A.1.D

    2. Algebraic Processes: Students will apply the operational properties when evaluating nonlinear expressions and solving nonlinear equations and inequalities. AT.A.2

        a. Explain symmetry of functions and determine whether a function is odd, even, or neither. AT.A.2.A

        b. Represent, interpret, and analyze inverses of functions algebraically and graphically using domain restrictions when necessary. AT.A.2.B

        c. Write equations of nonlinear functions (trigonometric, rational, higher-order polynomials, logarithmic and piecewise) using points of interest of the function. AT.A.2.C

        d. Convert between radian and degree measures of an angle. AT.A.2.D

        e. Use limits to describe the behavior of a function near its asymptotes and removable discontinuities. AT.A.2.E

    3. Applications: Students will solve authentic problems using nonlinear functions and relations. AT.A.3

        a. Analyze and model authentic situations using various non-linear representations and relations with appropriate technology. AT.A.3.A

        b. Analyze and model authentic application situations using various non-linear representations and relations with appropriate technology. AT.A.3.B

Geometry

3. Solve problems and reason with geometry using multiple representations, make connections within math and across disciplines, and communicate their ideas. HSA.CS.3
    1. Attributes: Students will identify and describe geometric attributes, apply properties and theorems, and create two- dimensional shapes. AT.G.1
        a. Apply the Law of Sines and the Law of Cosines to find unknown measures in triangles. AT.G.1.A
    2. Attributes: Students will identify and describe geometric attributes, apply properties and theorems, and create three-dimensional shapes. AT.G.2
        a. Determine the three-dimensional object created by rotating or revolving a two-dimensional object about an axis. AT.G.2.A
        b. Determine the shape of a two-dimensional cross-section of a three-dimensional object. AT.G.2.B
        c. Use Cavalieri's Principle to determine volume of three-dimensional figures. AT.G.2.C
    3. Coordinate Geometry and Transformations: Students will demonstrate and represent location, orientation, and relationships on the coordinate plane. AT.G.3
        a. Identify symmetry properties of a function (e.g., axis of symmetry of a parabola) and know the connection between its symmetry properties and specific transformations. AT.G.3.A
        b. Recognize that translations can be described in terms of vectors. AT.G.3.B
        c. Find the images and preimages of transformations of a point, shape, or relation on the coordinate plane, where transformations include the following compositions: reflections about lines of any rational slope passing through the origins, delations about the origin by any positive scale factor, and translations. AT.G.3.C
        d. Explain the focus-directrix construction of a parabola and derive the equation of a parabola from focus and directrix for a parabola whose axis of symmetry is a coordinate axis. AT.G.3.D
    4. Logic and Proof: Students will use geometric definitions and theorems to reason abstractly and quantitatively. AT.G.4
        a. Use known definitions and results in informal argumentation to construct logical arguments. AT.G.4.A
        b. Distinguish between empirical reasoning, examples, and deductive reasoning, as well as informal and formal reasoning. AT.G.4.B
        c. Evaluate the deductive consequences of alternative definitions of known objects (e.g., whether a trapezoid is defined as a quadrilateral with exactly one pair of parallel sides or defined as at least one pair of parallel sides). AT.G.4.C

Data

4. Solve problems and reason with data/probability using multiple representations, make connections within math and across disciplines, and communicate their ideas. HSA.CS.4
    1. Data Collection and Statistical Methods: Students will formulate statistical investigative questions, collect data, and organize data. AT.D.1
        a. Explain what constitutes good practice in designing a sample survey, an experiment, and an observational study. AT.D.1.A
        b. Explain the use of randomization to reduce the influence of confounding or lurking variables. AT.D.1.B
        c. Explain issues of bias and confounding variables in a study and their implications for interpretation. AT.D.1.C
        d. Demonstrate knowledge of the role sampling distributions play in the estimation of an unknown population parameter through the use of appropriate sampling techniques. AT.D.1.D
    2. Analyze Data and Interpret Results: Students will represent and analyze the data and interpret the results. AT.D.2
        a. Determine when a data set can be reasonably said to be normally distributed and draw conclusions about the data from the associated normal distribution. AT.D.2.A
        b. Use technology to develop regression models for linear and non-linear data to predict unobserved outcomes. Apply algebraic transformations to non-linear data to generate a linearized data set and employ linear regression techniques to analyze the non-linear data set. AT.D.2.B
    3. Probability: Students will interpret and apply concepts of probability. AT.D.3
        a. Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. Interpret the expected value as the mean of a probability distribution. AT.D.3.A
        b. Communicate what constitutes statistical significance. Interpret statistical significance in the context of a situation and answer investigative questions appropriately. AT.D.3.B
        c. Use data to compare two groups, describe sample variability, and decide if differences between parameters are significant based on the statistics. AT.D.3.C
        d. Use probability as a tool for assessing risk and for informed decision making by computing and interpreting P-values. AT.D.3.D
        e. Use confidence intervals to estimate an unknown population parameter. AT.D.3.E