

Statistical Algebra Curriculum

Course Description

This course focuses on the connections between mathematics and its applications to the real world. It starts with an introduction to statistics. The initial focus is univariate data and how to describe a collection of numbers in context. As we shift to bivariate data, we focus on functions through regression and the lens of real world applications. The ultimate goal is for students to attach real world concepts they are familiar with to algebraic ideas.

Grades: 10th to 12th

Course Priority Standards

- A2.DS.A.6 Make inferences and justify conclusions. Analyze decisions and strategies using probability concepts.
- A1.DS.A.5 Construct a scatter plot of bivariate quantitative data describing how the variables are related. Determine and use a function that models the relationship: a. Construct a linear function to model bivariate data represented on a scatter plot that minimizes residuals. b. construct an exponential function to model bivariate data represented on a scatter plot that minimizes residuals.
- A1.CED.A.2 Create and graph linear, quadratic and exponential equations in two variables.
- A1.BF.A.1: Build new functions from existing functions (limited to linear, quadratic and exponential). Analyze the effect of translations and scale changes on functions.

Course Enduring Understandings

- We use graphs & statistics to summarize the “story” the data is telling us.
- Not all statistics should be used in every context, nor is every graph appropriate for every situation.
- The probability of an event is the number of times we expect the event to occur over many, many trials.
- Knowing a random variable is normally distributed, we are able to calculate the probability of that event occurring.
- We are able to calculate the value of a random variable, if we know an associated probability.

Course Essential Questions

- How can we represent data?
- How can we calculate the probability of a given event?
- How can you make an inference on data?
- How do you know the regression model is appropriate?
- How do you interpret the intercepts of the regression model?
- How does changing the units of the x or y variable affect the model?
- How does adjusting the values of the explanatory or response variables affect the model? (vertical/horizontal shifts)

Course Essential Vocabulary

bar graphs, pie charts, dot plot, stem plot, histograms, mean, median, mode, weighted mean, quartiles, range, variance, standard deviation, interquartile range (IQR), quantitative variable, categorical variable, basic probability, sample space, joint probability, conditional probability, mutually exclusive events, independent events, complementary events, normal distribution, continuous variable, confidence, confidence interval, hypothesis tests, p-value, parameter, statistic, linear regression, slope, intercept, slope-intercept form, scatter plot, correlation, residuals, least-squares regression line (LSRL), correlation coefficient (r), correlation of determination (r -squared), consistent systems, inconsistent systems, axis of symmetry, complete the square, decreasing, difference of squares, factoring, increasing, maximum, minimum, perfect square trinomial, standard form, vertex form, vertex, y-intercept, x-intercepts, zeros, asymptote, base, domain, exponent, exponential decay, exponential form, exponential function, exponential growth, horizontal asymptote, consistent systems, inconsistent systems, matrix, identity matrix, inverse matrix, solution,

Course Resources & Materials

Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Math Medic, and teacher created materials

Unit 1	Descriptive Statistics (3 Weeks) Students will be able to calculate and interpret summary statistics to summarize a large set of data. This includes measures of center and measures of spread. Students will also use summary statistics to compare two different data sets.
Unit 1 Enduring Understandings	• Data sets are large, in general. • A list of numbers is not the best way to represent data. • We use graphs & statistics to summarize the “story” the data is telling us. • Not all statistics should be used in every context, nor is every graph appropriate for every situation.
Unit 1 Essential Questions	• Why do we represent data with statistics? • Why do we represent data with graphs? • Which graph is the best to use given the context? • Which statistics is best to use given the context?
Unit 1 Student Learning Goals	• Students will choose a graph that best represents the data given. • Students will describe a quantitative data set with statistics.
Unit 1 Vocabulary	bar graphs, pie charts, dot plot, stem plot, histograms, mean, median, mode, weighted mean, quartiles, range, variance, standard deviation, interquartile range (IQR), quantitative variable, categorical variable
Unit 1 Missouri Learning Standards	A1.DS.A.1: Summarize, represent and interpret data. Analyze and interpret graphical displays of data.
	A1.DS.A.2: Summarize, represent and interpret data. Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets.
	A1.DS.A.3: Summarize, represent and interpret data. Interpret differences in shape, center and spreads in the context of the data sets, accounting for possible effects of outliers.
	A1.DS.A.4a: Summarize, represent and interpret data. Summarize data in two-way frequency tables: a. Interpret relative frequencies in the context of the data.
	A1.DS.A.4b: Summarize, represent and interpret data: Summarize data in two-way frequency tables: b. Recognize possible associations and trends in the data.

	A1.DS.A.5a: Summarize, represent and interpret data: Construct a scatter plot of bivariate quantitative data describing how the variables are related; determine and use a function that models the relationship: a. Construct a linear function to model bivariate data represented on a scatter plot that minimizes residuals.
	A1.DS.A.5b: Summarize, represent and interpret data. Construct a scatter plot of bivariate quantitative data describing how the variables are related; determine and use a function that models the relationship: b. Construct an exponential function to model bivariate data represented on a scatter plot that minimizes residuals.
	A1.DS.A.6: Summarize, represent and interpret data. Interpret the slope (rate of change) and the y-intercept (constant term) of a linear model in the context of the data.
	A1.DS.A.7: Summarize, represent and interpret data. Determine and interpret the correlation coefficient for a linear association.
	A1.DS.A.8: Summarize, represent and interpret data. Distinguish between correlation and causation.
Unit 1 Assessments	PLC created and revised annually
Unit 1 Curricular Resources	Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Stats Medic, and teacher created materials

Unit 2	Basic Probability (4.5 Weeks) Students will look at the ideas around basic probability. This will include the fundamental definition of probability, and the properties of calculating probabilities of sequential events, conditional events, and complementary events. This unit will also focus on the tools to analyze sample spaces.
Unit 2 Enduring Understandings	• Larger numbers indicate greater likelihood. • Probability models are useful tools for making decisions and predictions. • Probability is a number between 0 and 1 that describes the chance that a stated event will occur.
Unit 2 Essential Questions	• What does the probability of an event mean? • How can we base decision on chance? • How can probability be used to simulate events and predict future happenings? • What are the benefits of simulating events as opposed to gathering real data?
Unit 2 Student Learning Goals	• Students will be able to define what the probability of an event means.

	• Students will be able to calculate the probability of an event. • Students will be able to calculate the probability of “and” event, conditional event, and “or” event.
Unit 2 Vocabulary	basic probability, sample space, joint probability, conditional probability, mutually exclusive events, independent events, complementary events
Unit 2 Missouri Learning Standards	G.CP.A.1: Understand independence and conditional probability and use them to interpret data. Describe events as subsets of a sample space using characteristics of the outcomes, or as unions, intersections or complements of other events.
	G.CP.A.2: Understand independence and conditional probability and use them to interpret data. Understand the definition of independent events and use it to solve problems.
	G.CP.A.3: Understand independence and conditional probability and use them to interpret data. Calculate conditional probabilities of events.
	G.CP.A.4: Understand independence and conditional probability and use them to interpret data. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities.
	G.CP.A.5: Understand independence and conditional probability and use them to interpret data. Recognize and explain the concepts of conditional probability and independence in a context.
	G.CP.A.6: Understand independence and conditional probability and use them to interpret data. Apply and interpret the Addition Rule for calculating probabilities.
	G.CP.A.7: Understand independence and conditional probability and use them to interpret data. Apply and Interpret the general Multiplication Rule in a uniform probability model.
	G.CP.A.8: Understand independence and conditional probability and use them to interpret data. Use permutations and combinations to solve problems.
Unit 2 Assessments	PLC created and revised annually
Unit 2 Curricular Resources	Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Stats Medic, and teacher created materials

Unit 3	Normal Distributions (3.5 Weeks) This unit is a look at continuous random variables that are normally distributed. It is foundational to sequential units involving inference.
Unit 3 Enduring Understandings	- Knowing a random variable is normally distributed, we are able to calculate the probability of that event occurring. - We are able to calculate the value of a random variable, if we know an associated probability.
Unit 3 Essential Questions	- What is the benefit of knowing a random variable is normally distributed? - Knowing the probability of the event, why can you calculate the value of the random variable?
Unit 3 Student Learning Goals	- Students will calculate the probability of a normal event. - Students will calculate the value of a random normal variable, given its probability.
Unit 3 Vocabulary	normal distribution, continuous variable, bounds, infinity, random variable
Unit 3 Missouri Learning Standards	A2.DS.A.2: Make inferences and justify conclusions. Determine whether a specified model is consistent with a given data set.
	A2.DS.B.8: Fit a data set to a normal distribution. Know and use the characteristics of normally distributed data sets; predict what percentage of the data will be above or below a given value that is a multiple of standard deviations above or below the mean.
	A2.DS.B.9: Fit a data set to a normal distribution. Fit a data set to a distribution using its mean and standard deviation to determine whether the data is approximately normally distributed.
Unit 3 Assessments	PLC created and revised annually
Unit 3 Curricular Resources	Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Stats Medic, and teacher created materials

Unit 4	Inference (4.5 Weeks) Students will be able to run a statistical inference procedure to answer a real world question.
Unit 4 Enduring Understandings	- In order to estimate an unknown quantity, we make a confidence interval. - In order to test an existing belief, we can run a hypothesis test.

	Confidence is commentary on the effectiveness of our methodology.
Unit 4 Essential Questions	- Why do you make a confidence interval? - How do you interpret a confidence interval? - Why do you run a hypothesis test? - How do you interpret the results of a hypothesis test?
Unit 4 Student Learning Goals	- Students will construct a confidence interval for a population mean. - Students will interpret a confidence interval for a population mean. - Students will run a hypothesis test for a population mean. - Students will interpret a p-value from a hypothesis test for a population mean.
Unit 4 Vocabulary	confidence, confidence interval, hypothesis tests, p-value, parameter, statistic
Unit 4 Missouri Learning Standards	A2.DS.A.2: Make inferences and justify conclusions. Determine whether a specified model is consistent with a given data set.
	A2.DS.A.3: Make inferences and justify conclusions. Describe and explain the purposes, relationship to randomization and differences among sample surveys, experiments and observational studies.
	A2.DS.A.4: Make inferences and justify conclusions. Use data from a sample to estimate characteristics of the population and recognize the meaning of the margin of error in these estimates.
	A2.DS.A.5: Make inferences and justify conclusions. Describe and explain how the relative sizes of a sample and the population affect the margin of error of predictions.
	A2.DS.A.6: Make inferences and justify conclusions. Analyze decisions and strategies using probability concepts.
	A2.DS.A.7: Make inferences and justify conclusions. Evaluate reports based on data.
	A2.DS.B.8: Fit a data set to a normal distribution. Know and use the characteristics of normally distributed data sets; predict what percentage of the data will be above or below a given value that is a multiple of standard deviations above or below the mean.
	A2.DS.B.9: Fit a data set to a normal distribution. Fit a data set to a distribution using its mean and standard deviation to determine whether the data is approximately normally distributed.
Unit 4 Assessments	Students will ask a question they want to know the answer to, gather data, perform an inference procedure and present to the class.
Unit 4 Curricular Resources	Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Stats Medic, and teacher created materials

Unit 5	Linear Regression (4.5 Weeks) Students will learn to write a linear model to quantify the relationship between two quantitative variables by minimizing errors. Students will be able to evaluate the appropriateness of a regression line.
Unit 5 Enduring Understandings	• A LSRL can be used to represent a linear relationship between two quantitative variables. • The LSRL is appropriate when at least the y-intercept or slope has a meaning in the context, the correlation coefficient and coefficient of determination indicate a moderate to strong relationship, and the residual plot is random.
Unit 5 Essential Questions	• Why do you write a least-squares regression line (LSRL)? • How do you know if a LSRL is appropriate?
Unit 5 Student Learning Goals	• Students will construct a linear regression model to explain the relationship between two variables. • Students will construct a scatter plot. • Students will use a linear regression model to predict the value of a response variable. • Students will interpret the slope of a linear regression model. • Students will interpret the y-intercept of a linear regression model.
Unit 5 Vocabulary	linear regression, slope, intercept, slope-intercept form, scatter plot, correlation, residuals, least-squares regression line (LSRL), correlation coefficient (r), correlation of determination (r -squared), explanatory variable, response variable
Unit 5 Missouri Learning Standards	A2.BF.A.3: Create new functions from existing functions. Describe the effects of transformations algebraically and graphically, creating vertical and horizontal translations, vertical and horizontal reflections and dilations (expansions/compressions) for linear, quadratic, cubic, square and cube root, absolute value, exponential and logarithmic functions.
	A2.FM.A.1: Use functions to model real-world problems. Create functions and use them to solve applications of quadratic and exponential function model problems.
	A2.DS.A.2: Make inferences and justify conclusions. Determine whether a specified model is consistent with a given data set.
	A1.CED.A.2: Create equations that describe linear, quadratic and exponential relationships. Create and graph linear, quadratic and exponential equations in two variables.
Unit 5 Assessments	PLC created and revised annually

Unit 5 Curricular Resources	Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Stats Medic, and teacher created materials
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Unit 6	Linear Systems (4 Weeks) Students will learn to solve systems of equations and inequalities graphically and algebraically. Systems will be tied into previous unit and Least-Squares Regression lines.
Unit 6 Enduring Understandings	A system of linear equations is an algebraic way to compare two equations that model a situation.
Unit 6 Essential Questions	- What does the number of solutions of a system of linear equations represent? - Which method is most efficient when solving a system of linear equations? - How can systems of equations be used to represent situations and solve problems?
Unit 6 Student Learning Goals	- Students will solve a linear system using any method. - Students will solve a system of linear inequalities. - Students will explain what it means to be a solution to a linear system or a linear inequality. - Students will solve real world applications involving linear applications. - Students will solve a system by graphing. - Students will solve a system using substitution. - Students will solve a system using elimination. - Students will solve problems of applications of systems. - Students will determine the most efficient method when solving a system of linear equations. - Students will explain what is meant by the solution to a system of linear equations. - Students will explain what is meant by the solutions to a system of inequalities.
Unit 6 Vocabulary	consistent systems, inconsistent systems, substitution, elimination, infinitely many solutions, parallel lines, coinciding line, point of intersection
Unit 6 Missouri Learning Standards	A2.REI.B.3: Solve general systems of equations and inequalities. Create and solve systems of equations that may include non-linear equations and inequalities. A2.FM.A.1: Use functions to model real-world problems. Create functions and use them to solve applications of quadratic and exponential function model problems.
Unit 6 Assessments	PLC created and revised annually

Unit 6 Curricular Resources	Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Stats Medic, and teacher created materials
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Unit 7	Quadratic Regression (4.5 Weeks) Students will study quadratic relationships through the lens of quadratic regression. . Students will build quadratic models and interpret the parts of the quadratic in context. Students will evaluate those models.
Unit 7 Enduring Understandings	• The characteristics of quadratic functions and their representations are useful in solving real-world problems. • Quadratic functions can be used to model real world relationships and the key points in quadratic functions have meaning in the real world context.
Unit 7 Essential Questions	• How does understanding how to find the vertex of a quadratic function help in making decisions in real-life applications? • Which method is most efficient when solving a quadratic equation? • How is a quadratic function used to model a situation? • What are the advantages of a quadratic function in vertex form? Standard form?
Unit 7 Student Learning Goals	• Students will apply a quadratic regression to explain the relationship between two variables. • Students will explain how changing the values of the response and explanatory variables affects the regression model. • Students will explain the significance of the vertex of the parabola in the context of a real world application. • Students will solve a quadratic equation. • Students will graph quadratics in vertex and standard form. • Students will be able to convert between vertex and standard form by completing the square. • Students will solve quadratic equations. • Students will graph quadratic functions. • Students will model quadratic situations and apply that model to a new situation.
Unit 7 Vocabulary	axis of symmetry, complete the square, decreasing, difference of squares, factoring, increasing, maximum, minimum, perfect square trinomial, standard form, vertex form, vertex, y-intercept, x-intercepts, zeros
Unit 7 Missouri Learning Standards	A2.BF.A.3: Create new functions from existing functions: Describe the effects of transformations algebraically and graphically, creating vertical and horizontal translations, vertical and horizontal reflections and dilations (expansions/compressions) for linear, quadratic, cubic, square and cube root, absolute value, exponential and logarithmic functions.

	A2.FM.A.1: Use functions to model real-world problems. Create functions and use them to solve applications of quadratic and exponential function model problems.
	A2.DS.A.2: Make inferences and justify conclusions. Determine whether a specified model is consistent with a given data set.
Unit 7 Assessments	PLC created and revised annually
Unit 7 Curricular Resources	Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Stats Medic, and teacher created materials

Unit 8	Exponential Regression (5 Weeks) Students will study exponential relationships between two quantitative variables. Students will build exponential models and evaluate those models. Students will interpret the parts of exponential functions (e.g. intercepts asymptotes).
Unit 8 Big Ideas	- Exponents are used to represent complex expressions. - Linear functions have a constant difference, whereas exponential functions have a constant ratio. - Real world situations can be represented symbolically and graphically.
Unit 8 Essential Questions	- How do you find the asymptote of an exponential function? - What is the significance of the asymptote of an exponential function? - How do you find the intercepts of the exponential function? - What is the significance of the intercepts of the exponential function? - How does changing the units of the x or y variable affect the exponential function? - How does adjusting the values of the explanatory or response variables affect the exponential function? (vertical/horizontal shifts)
Unit 8 Student Learning Goals	- Students will apply an exponential regression to explain the relationship between two variables. - Students will explain how changing the values of the response and explanatory variables affects the regression model. - Students will explain the real world significance of the x and/or y intercepts of an exponential regression model. - Students will solve an exponential equation. - Students will simplify expressions by applying exponent rules. - Students will solve exponential equations with common bases.

	- Students will solve equations with rational exponents. - Students will model exponential situations and apply that model to a new situation. - Students will graph exponential functions.
Unit 8 Vocabulary	asymptote, base, domain, exponent, exponential decay, exponential form, exponential function, exponential growth, horizontal asymptote
Unit 8 Missouri State Standards	A2.SSE.A.1: Define and use logarithms. Develop the definition of logarithms based on properties of exponents.
	A2.SSE.A.2: Define and use logarithms. Use the inverse relationship between exponents and logarithms to solve exponential and logarithmic equations.
	A2.SSE.A.4: Define and use logarithms. Understand why logarithmic scales are used, and use them to solve problems.
	A2.BF.A.3: Create new functions from existing functions. Describe the effects of transformations algebraically and graphically, creating vertical and horizontal translations, vertical and horizontal reflections and dilations (expansions/compressions) for linear, quadratic, cubic, square and cube root, absolute value, exponential and logarithmic functions.
	A2.DS.A.2: Make inferences and justify conclusions. Determine whether a specified model is consistent with a given data set.
	A2.FM.A.1: Use functions to model real-world problems. Create functions and use them to solve applications of quadratic and exponential function model problems.
Unit 8 Assessments	PLC created and revised annually
Unit 8 Curricular Resources	Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Stats Medic, and teacher created materials

Unit 9	Systems of Nonlinear Equations (4.5 Weeks) Students will learn to solve systems of equations and inequalities graphically and algebraically. Students will extend their previous techniques to 3 dimensions or more as well as learn advanced tools to help them solve higher-order systems.
Unit 9 Enduring	Systems of nonlinear equations can be used to model and solve many applications.

Understandings	
Unit 9 Essential Questions	• What is a matrix? • How can a matrix be used to solve higher order equations? • How can you find the solution to a nonlinear system of equations? • How do you know if a point is a solution to a nonlinear system of equations?
Student Learning Goals	• Students will solve a higher order system of linear equations with a matrix. • Students will solve a system of nonlinear equations. • Students will be able to identify a matrix. • Students will be able to use a matrix to solve higher order equations. • Students will be able to solve nonlinear systems of equations. • Students will know that solutions to systems occur at coordinates who generate a true statement when the coordinates are plugged into the original system.
Unit 9 Vocabulary	consistent systems, inconsistent systems, matrix, identity matrix, inverse matrix, solution
Unit 9 Missouri State Standards	A2.REI.B.3: Solve general systems of equations and inequalities. Create and solve systems of equations that may include non-linear equations and inequalities.
	A2.BF.A.3: Create new functions from existing functions. Describe the effects of transformations algebraically and graphically, creating vertical and horizontal translations, vertical and horizontal reflections and dilations (expansions/compressions) for linear, quadratic, cubic, square and cube root, absolute value, exponential and logarithmic functions.
	A2.FM.A.1: Use functions to model real-world problems. Create functions and use them to solve applications of quadratic and exponential function model problems.
Unit 9 Assessments	PLC created and revised annually
Unit 9 Curricular Resources	Stats in Your World, DeltaMath, Desmos, Infinite Algebra Series, ACT prep book, Stats Medic, and teacher created materials