Virginia Mathematics

Probability and Statistics

Data in Context	DC.1	The student will use a statistical cycle to formulate questions, describe types of data, data sources, and constraints within the context of a problem. PS.DC.1
	DC.2	The student will compare and contrast data collection methods to plan and conduct an observational study. PS.DC.2
	DC.3	The student will utilize the principles of experimental design to plan and conduct a well-designed experiment. PS.DC.3
Define the stages of the statistical cycle and how each stage relates to the others. PS.DC.1.A	a	Define the stages of the statistical cycle and how each stage relates to the others. PS.DC.1.A
Formulate questions and conclusions based on context. PS.DC.1.B	b	Formulate questions and conclusions based on context. PS.DC.1.B
Understand the type of data relevant to the question at hand (e.g., quantitative versus categorical). PS.DC.1.C	c	Understand the type of data relevant to the question at hand (e.g., quantitative versus categorical). PS.DC.1.C
Compare and contrast population and sample, and parameter and statistic. PS.DC.1.D	d	Compare and contrast population and sample, and parameter and statistic. PS.DC.1.D
Identify and explain constraints of the statistical approach. PS.DC.1.E	e	Identify and explain constraints of the statistical approach. PS.DC.1.E
Investigate and describe sampling techniques (e.g., simple random sampling, stratified sampling, systematic	a	Investigate and describe sampling techniques (e.g., simple random sampling, stratified sampling, systematic sampling, cluster sampling). PS.DC.2.A

sampling, cluster sampling). PS.DC.2.A	
Determine which sampling technique is best, given a particular context. PS.DC.2.B	b Determine which sampling technique is best, given a particular context. PS.DC.2.B
Investigate and explain biased influences inherent within sampling methods and various forms of response bias. PS.DC.2.C	c Investigate and explain biased influences inherent within sampling methods and various forms of response bias. PS.DC.2.C
Use the statistical cycle to plan and conduct an observational study to answer a question or address a problem. PS.DC.2.D	d Use the statistical cycle to plan and conduct an observational study to answer a question or address a problem. PS.DC.2.D
Describe the principles of experimental design, including: PS.DC.3.A	a Describe the principles of experimental design, including: PS.DC.3.A
treatment/control groups; PS.DC.3.A.I	i treatment/control groups; PS.DC.3.A.I
blinding/placebo effects; PS.DC.3.A.II	ii blinding/placebo effects; PS.DC.3.A.II
experimental units/subjects; and PS.DC.3.A.III	iii experimental units/subjects; and PS.DC.3.A.III
blocking/matched pairs and completely randomized designs. PS.DC.3.A.IV	iv blocking/matched pairs and completely randomized designs. PS.DC.3.A.IV
Evaluate the principles of experimental design to address comparison, randomization, replication, and control	b Evaluate the principles of experimental design to address comparison, randomization, replication, and control within the context of the problem. PS.DC.3.B

within the context of the problem. PS.DC.3.B	
Compare and contrast controlled experiments and observational studies and the conclusions that may be drawn from each. PS.DC.3.C	c Compare and contrast controlled experiments and observational studies and the conclusions that may be drawn from each. PS.DC.3.C
Use the statistical cycle to plan and conduct a well-designed experiment to answer a question or address a problem. PS.DC.3.D	d Use the statistical cycle to plan and conduct a well-designed experiment to answer a question or address a problem. PS.DC.3.D
Select a data collection method appropriate for a given context. PS.DC.3.E	e Select a data collection method appropriate for a given context. PS.DC.3.E
Descriptive Statistics	DS.1 The student will represent and analyze data visualizations of univariate quantitative data, including dot plots, stemplots, boxplots, cumulative frequency graphs, and histograms, to identify and describe patterns and departures from patterns, using central tendency, spread, clusters, gaps, and outliers, within the context of a problem. PS.DS.1
	DS.2 The student will represent and analyze numerical characteristics of univariate quantitative data sets to describe patterns and departures from patterns within the context of a problem PS.DS.2
	DS.3 The student will represent, compare, and analyze distributions of two or more univariate quantitative data sets, numerically and graphically. PS.DS.3
	DS.4 The student will represent and analyze categorical data, using two-way tables and other graphical displays, to describe patterns and relationships. PS.DS.4
	DS.5 The student will represent and analyze quantitative bivariate data with scatterplots to identify and describe the relationship between two variables. PS.DS.5
	DS.6 The student will create and interpret a linear model using the least squares regression method to assess the relationship between two quantitative variables PS.DS.6

Create and interpret graphical displays of data, including dot plots, stemplots, boxplots, cumulative frequency graphs, and histograms, using appropriate technology. PS.DS.1.A	a Create and interpret graphical displays of data, including dot plots, stemplots, boxplots, cumulative frequency graphs, and histograms, using appropriate technology. PS.DS.1.A
Examine the graphs within the context of the problem by analyzing: PS.DS.1.B	b Examine the graphs within the context of the problem by analyzing: PS.DS.1.B
shape; PS.DS.1.B.I	i shape; PS.DS.1.B.I
measures of center; PS.DS.1.B.II	ii measures of center; PS.DS.1.B.II
spread; and PS.DS.1.B.III	iii spread; and PS.DS.1.B.III
unusual features of the data (e.g., outliers, clusters, gaps). PS.DS.1.B.IV	iv unusual features of the data (e.g., outliers, clusters, gaps). PS.DS.1.B.IV
Interpret measures of central tendency: mean, median, and mode. PS.DS.2.A	a Interpret measures of central tendency: mean, median, and mode. PS.DS.2.A
Interpret measures of spread: range, interquartile range, variance, and standard deviation. PS.DS.2.B	b Interpret measures of spread: range, interquartile range, variance, and standard deviation. PS.DS.2.B
Identify possible outliers, using an algorithm. PS.DS.2.C	c Identify possible outliers, using an algorithm. PS.DS.2.C
Investigate and explain the influence of outliers on a univariate data set. PS.DS.2.D	d Investigate and explain the influence of outliers on a univariate data set. PS.DS.2.D

Investigate and explain ways in which standard deviation addresses variability by examining the formula for standard deviation. PS.DS.2.E	e Investigate and explain ways in which standard deviation addresses variability by examining the formula for standard deviation. PS.DS.2.E
Create graphical displays of data, including back-to-back stemplots, parallel dot plots, parallel boxplots, and histograms, using appropriate technology. PS.DS.3.A	a Create graphical displays of data, including back-to-back stemplots, parallel dot plots, parallel boxplots, and histograms, using appropriate technology. PS.DS.3.A
Compare and contrast two or more univariate data sets, numerically and graphically, within the context of a problem by analyzing: PS.DS.3.B	b Compare and contrast two or more univariate data sets, numerically and graphically, within the context of a problem by analyzing: PS.DS.3.B
shape; PS.DS.3.B.I	i shape; PS.DS.3.B.I
measures of center; PS.DS.3.B.II	ii measures of center; PS.DS.3.B.II
measures of spread; and PS.DS.3.B.III	iii measures of spread; and PS.DS.3.B.III
unusual features of the data (e.g., clusters, gaps, outliers). PS.DS.3.B.IV	iv unusual features of the data (e.g., clusters, gaps, outliers). PS.DS.3.B.IV
Create and interpret graphical displays of univariate categorical data, including bar graphs within the context of the problem, using appropriate technology. PS.DS.4.A	a Create and interpret graphical displays of univariate categorical data, including bar graphs within the context of the problem, using appropriate technology. PS.DS.4.A

Create and interpret graphical displays comparing distributions of two or more univariate categorical data sets including segmented and side-by-side bar graphs within the context of the problem, using appropriate technology. PS.DS.4.B	b Create and interpret graphical displays comparing distributions of two or more univariate categorical data sets including segmented and side-by-side bar graphs within the context of the problem, using appropriate technology. PS.DS.4.B
Generate and interpret a two-way table as a summary of the information obtained from two categorical variables. PS.DS.4.C	c Generate and interpret a two-way table as a summary of the information obtained from two categorical variables. PS.DS.4.C
Calculate and interpret marginal, relative, and conditional frequencies to analyze data in a two-way table within the context of a problem. PS.DS.4.D	d Calculate and interpret marginal, relative, and conditional frequencies to analyze data in a two-way table within the context of a problem. PS.DS.4.D
Create scatterplots, using appropriate technology. PS.DS.5.A	a Create scatterplots, using appropriate technology. PS.DS.5.A
Examine and interpret scatterplots in the context of the problem by analyzing: PS.DS.5.B	b Examine and interpret scatterplots in the context of the problem by analyzing: PS.DS.5.B
the form of relationship for linear and nonlinear trends; PS.DS.5.B.I	i the form of relationship for linear and nonlinear trends; PS.DS.5.B.I
the direction of the relationship for positive, negative, or no association; PS.DS.5.B.II	ii the direction of the relationship for positive, negative, or no association; PS.DS.5.B.II
the strength of the relationship such as	iii the strength of the relationship such as strong, moderate, or weak; and PS.DS.5.B.III

strong, moderate, or weak; and PS.DS.5.B.III	
the presence of unusual features within the data (e.g., clusters, gaps, influential points, outliers). PS.DS.5.B.IV	iv the presence of unusual features within the data (e.g., clusters, gaps, influential points, outliers). PS.DS.5.B.IV
Create the least squares regression model using technology to interpret the contextual meaning of the slope and y-intercept. PS.DS.6.A	a Create the least squares regression model using technology to interpret the contextual meaning of the slope and y-intercept. PS.DS.6.A
Using technology, calculate and interpret the correlation coefficient, r, within the context of a problem. PS.DS.6.B	b Using technology, calculate and interpret the correlation coefficient, r, within the context of a problem. PS.DS.6.B
Using technology, calculate and interpret the coefficient of determination, r 2 , within the context of a problem. PS.DS.6.C	c Using technology, calculate and interpret the coefficient of determination, r 2 , within the context of a problem. PS.DS.6.C
Use regression lines to make predictions, and identify the limitations of the predictions, such as extrapolation. PS.DS.6.D	d Use regression lines to make predictions, and identify the limitations of the predictions, such as extrapolation. PS.DS.6.D
Calculate and interpret a residual to understand the error of a prediction. PS.DS.6.E	e Calculate and interpret a residual to understand the error of a prediction. PS.DS.6.E
Using technology, calculate and interpret the standard deviation of the residuals, s. PS.DS.6.F	f Using technology, calculate and interpret the standard deviation of the residuals, s. PS.DS.6.F

Probability	**P.1** The student will organize information and apply probability rules to compute probabilities of events within the context of a problem. PS.P.1
	P.2 The student will represent and interpret situations using discrete random distributions, including binomial distributions. PS.P.2
	P.3 The student will represent and interpret situations using normal distributions. PS.P.3
Given two or more events, determine whether the events are complementary, dependent, independent, and/or mutually exclusive, and compute the probability of those events. PS.P.1.A	**a** Given two or more events, determine whether the events are complementary, dependent, independent, and/or mutually exclusive, and compute the probability of those events. PS.P.1.A
Represent and calculate probabilities using Venn diagrams, tree diagrams, and two-way tables. PS.P.1.B	**b** Represent and calculate probabilities using Venn diagrams, tree diagrams, and two-way tables. PS.P.1.B
Apply the addition rule, the multiplication rule, and complementary rule to calculate probabilities. PS.P.1.C	**c** Apply the addition rule, the multiplication rule, and complementary rule to calculate probabilities. PS.P.1.C
Calculate conditional probabilities to determine the association or independence of two events. PS.P.1.D	**d** Calculate conditional probabilities to determine the association or independence of two events. PS.P.1.D
Identify discrete random variables and create a table to represent valid discrete probability distributions within the context of a problem. PS.P.2.A	**a** Identify discrete random variables and create a table to represent valid discrete probability distributions within the context of a problem. PS.P.2.A

Calculate and interpret the mean (expected value) and standard deviation for a discrete random variable within the context of a problem. PS.P.2.B	**b** **Calculate and interpret the mean (expected value) and standard deviation for a discrete random variable within the context of a problem.** PS.P.2.B
Determine if a discrete random variable satisfies the conditions for a binomial distribution. PS.P.2.C	**c** **Determine if a discrete random variable satisfies the conditions for a binomial distribution.** PS.P.2.C
Design and conduct a simulation of a binomial distribution. PS.P.2.D	**d** **Design and conduct a simulation of a binomial distribution.** PS.P.2.D
Calculate and interpret probabilities from a binomial distribution within the context of a problem. PS.P.2.E	**e** **Calculate and interpret probabilities from a binomial distribution within the context of a problem.** PS.P.2.E
Calculate the mean and standard deviation for binomial distributions. PS.P.2.F	**f** **Calculate the mean and standard deviation for binomial distributions.** PS.P.2.F
Describe the center, shape, and spread of a discrete random variable within the context of a problem. PS.P.2.G	**g** **Describe the center, shape, and spread of a discrete random variable within the context of a problem.** PS.P.2.G
Compare and contrast discrete and continuous distributions. PS.P.3.A	**a** **Compare and contrast discrete and continuous distributions.** PS.P.3.A
Represent probability as the area under the curve of a normal distribution using the Empirical Rule and graphing technology. PS.P.3.B	**b** **Represent probability as the area under the curve of a normal distribution using the Empirical Rule and graphing technology.** PS.P.3.B

Describe the center, shape, and spread of normal distributions within the context of a problem. PS.P.3.C	**c** Describe the center, shape, and spread of normal distributions within the context of a problem. PS.P.3.C
Compare and contrast two or more sets of normally distributed data using z-scores, percentiles, or probabilities within the context of a problem. PS.P.3.D	**d** Compare and contrast two or more sets of normally distributed data using z-scores, percentiles, or probabilities within the context of a problem. PS.P.3.D
Standardize a data value from a normal distribution and interpret the z-score within the context of a problem. PS.P.3.E	**e** Standardize a data value from a normal distribution and interpret the z-score within the context of a problem. PS.P.3.E
Calculate and interpret probabilities of a normal distribution using technology within the context of a problem. PS.P.3.F	**f** Calculate and interpret probabilities of a normal distribution using technology within the context of a problem. PS.P.3.F
Inferential Statistics	**IS.1** The student will apply properties of sampling distributions and inference procedures to make decisions about population proportions. The student will apply properties of sampling distributions and inference procedures to make decisions about population proportions. PS.IS.1
	IS.2 The student will apply properties of sampling distributions and inference procedures to make decisions about populations. PS.IS.2
Describe the shape, center, and spread of the sampling distribution of a proportion within the context of a problem. PS.IS.1.A	**a** Describe the shape, center, and spread of the sampling distribution of a proportion within the context of a problem. PS.IS.1.A
Given a problem, construct a one sample z confidence interval: PS.IS.1.B	**b** Given a problem, construct a one sample z confidence interval: PS.IS.1.B

identify the basic conditions for inference: random sample, independence, and normality; PS.IS.1.B.I	i identify the basic conditions for inference: random sample, independence, and normality; PS.IS.1.B.I
calculate a confidence interval using technology; and PS.IS.1.B.II	ii calculate a confidence interval using technology; and PS.IS.1.B.II
interpret the interval within the context of the problem. PS.IS.1.B.III	iii interpret the interval within the context of the problem. PS.IS.1.B.III
Explain how changes in confidence level and sample size affect width of the confidence interval and margin of error. PS.IS.1.C	c Explain how changes in confidence level and sample size affect width of the confidence interval and margin of error. PS.IS.1.C
Calculate and interpret a point estimate and margin of error of a confidence interval for a proportion within the context of the problem. PS.IS.1.D	d Calculate and interpret a point estimate and margin of error of a confidence interval for a proportion within the context of the problem. PS.IS.1.D
Explain how and why the hypothesis testing procedure allows one to reach a statistical decision. PS.IS.1.E	e Explain how and why the hypothesis testing procedure allows one to reach a statistical decision. PS.IS.1.E
Given a problem, apply the one sample z hypothesis testing procedures: PS.IS.1.F	f Given a problem, apply the one sample z hypothesis testing procedures: PS.IS.1.F
construct appropriate null and alternate hypotheses; PS.IS.1.F.I	i construct appropriate null and alternate hypotheses; PS.IS.1.F.I

identify the basic conditions for inference: random sample; independence, and normality; PS.IS.1.F.II	ii identify the basic conditions for inference: random sample; independence, and normality; PS.IS.1.F.II
calculate and interpret the p-value using technology; PS.IS.1.F.III	iii calculate and interpret the p-value using technology; PS.IS.1.F.III
determine and justify whether to reject the null hypothesis; and PS.IS.1.F.IV	iv determine and justify whether to reject the null hypothesis; and PS.IS.1.F.IV
interpret the results within the context of the problem. PS.IS.1.F.V	v interpret the results within the context of the problem. PS.IS.1.F.V
Use the statistical cycle to plan and conduct a statistical study about a proportion to answer a question or address a problem with inference. PS.IS.1.G	g Use the statistical cycle to plan and conduct a statistical study about a proportion to answer a question or address a problem with inference. PS.IS.1.G
Describe the shape, center, and spread of the sampling distribution of a mean within the context of a problem. PS.IS.2.A	a Describe the shape, center, and spread of the sampling distribution of a mean within the context of a problem. PS.IS.2.A
Calculate and interpret a point estimate and a margin of error for a confidence interval of a mean within the context of a problem. PS.IS.2.B	b Calculate and interpret a point estimate and a margin of error for a confidence interval of a mean within the context of a problem. PS.IS.2.B
Describe the use of the Central Limit Theorem in satisfying the assumptions and conditions for inference about a mean. PS.IS.2.C	c Describe the use of the Central Limit Theorem in satisfying the assumptions and conditions for inference about a mean. PS.IS.2.C

Identify the properties of a t distribution. PS.IS.2.D	**d Identify the properties of a t distribution.** PS.IS.2.D
Given a problem, construct a one sample t confidence interval: PS.IS.2.E	**e Given a problem, construct a one sample t confidence interval:** PS.IS.2.E
identify the basic conditions for inference: random sample, independence, and approximate normality; PS.IS.2.E.I	**i identify the basic conditions for inference: random sample, independence, and approximate normality;** PS.IS.2.E.I
calculate a confidence interval using technology; and PS.IS.2.E.II	**ii calculate a confidence interval using technology; and** PS.IS.2.E.II
interpret the interval within the context of the problem. PS.IS.2.E.III	**iii interpret the interval within the context of the problem.** PS.IS.2.E.III
Given a problem, apply the one sample t hypothesis testing procedures: PS.IS.2.F	**f Given a problem, apply the one sample t hypothesis testing procedures:** PS.IS.2.F
construct appropriate null and alternate hypotheses; PS.IS.2.F.I	**i construct appropriate null and alternate hypotheses;** PS.IS.2.F.I
identify the basic conditions for inference: random sample, independence, and approximate normality; PS.IS.2.F.II	**ii identify the basic conditions for inference: random sample, independence, and approximate normality;** PS.IS.2.F.II
calculate and interpret the p value using technology; PS.IS.2.F.III	**iii calculate and interpret the p value using technology;** PS.IS.2.F.III

determine and justify whether to reject the null hypothesis; and PS.IS.2.F.IV	**iv** **determine and justify whether to reject the null hypothesis; and** PS.IS.2.F.IV
interpret the results within the context of the problem. PS.IS.2.F.V	**v** **interpret the results within the context of the problem.** PS.IS.2.F.V