



North Carolina Department of Public Instruction

INSTRUCTIONAL SUPPORT TOOLS

FOR ACHIEVING NEW STANDARDS

This document is designed to help North Carolina educators teach the Common Core (Standard Course of Study). NCDPI staff are continually updating and improving these tools to better serve teachers.

Statistics and Probability • Unpacked Content

For the new Common Core standards that will be effective in all North Carolina schools in the 2012-13 school year.

What is the purpose of this document?

To increase student achievement by ensuring educators understand specifically what the new standards mean a student must know, understand and be able to do.

What is in the document?

Descriptions of what each standard means a student will know, understand and be able to do. The “unpacking” of the standards done in this document is an effort to answer a simple question “What does this standard mean that a student must know and be able to do?” and to ensure the description is helpful, specific and comprehensive for educators.

How do I send Feedback?

We intend the explanations and examples in this document to be helpful and specific. That said, we believe that as this document is used, teachers and educators will find ways in which the unpacking can be improved and made ever more useful. Please send feedback to us at feedback@dpi.state.nc.us and we will use your input to refine our unpacking of the standards. Thank You!

Interpreting Categorical and Quantitative Data

S.ID

Common Core Cluster

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

Common Core Standard	Unpacking What does this standard mean that a student will know and be able to do?
S.ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).	S.ID.1 Construct dot plots, histograms and box plots for data on a real number line.
S.ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.	S.ID.2 Describe a distribution using center and spread. S.ID.2 Use the correct measure of center and spread to describe a distribution that is symmetric or skewed. S.ID.2 Identify outliers (extreme data points) and their effects on data sets. S.ID.2 Compare two or more different data sets using the center and spread of each.
S.ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).	S.ID.3 Interpret differences in different data sets in context. Interpret differences due to possible effects of outliers.

S.ID.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, spreadsheets, and tables to estimate areas under the normal curve.

S.ID.4 Identify data sets as approximately normal or not.

S.ID.4 Use the mean and standard deviation to fit it to a normal distribution where appropriate.

S.ID.4 Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

S.ID.4 Interprets areas under a normal curve in context.

Instructional Expectations

In both pathways, the expectation in **Algebra I** and **CCSS Mathematics I**, is that in grades 6 – 8, students describe center and spread in a data distribution. Here they choose a summary statistic appropriate to the characteristics of the data distribution, such as the shape of the distribution or the existence of extreme data points. In **Algebra II** and **CCSS Mathematics III**, while students may have heard of the normal distribution, it is unlikely that they will have prior experience using it to make specific estimates. Build on students' understanding of data distributions to help them see how the normal distribution uses area to make estimates of frequencies (which can be expressed as probabilities). Emphasize that only some data are well described by a normal distribution.

Common Core Cluster

Summarize, represent, and interpret data on two categorical and quantitative variables.

Common Core Standard	Unpacking What does this standard mean that a student will know and be able to do?
<p>S.ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.</p>	<p>S.ID.5 Create a two-way table from two categorical variables and read values from two way table. Interpret joint, marginal, and relative frequencies in context.</p> <p>S.ID.5 Recognize associations and trends in data from a two-way table.</p>
<p>S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.</p> <p>a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.</p> <p>b. Informally assess the fit of a function by plotting and analyzing residuals.</p> <p>c. Fit a linear function for a scatter plot that suggests a linear association.</p>	<p>S.ID.6 Create a scatter plot from two quantitative variables.</p> <p>S.ID.6 Describe the form, strength and direction of the relationship.</p> <p>S.ID.6a Categorize data as linear or not. Use algebraic methods and technology to fit a linear function to the data. Use the function to predict values.</p> <p>S.ID.6a Explain the meaning of the slope and y-intercept in context.</p> <p>S.ID.6a Categorize data as exponential. Use algebraic methods and technology to fit an exponential function to the data. Use the function to predict values.</p> <p>S.ID.6a Explain the meaning of the growth rate and y-intercept in context.</p> <p>S.ID.6a Categorize data as quadratic. Use algebraic methods and technology to fit a quadratic function to the data. Use the function to predict values.</p> <p>S.ID.6a Explain the meaning of the constant and coefficients in context.</p>

	<p>S.ID.6b Calculate a residual. Create and analyze a residual plot.</p> <p>S.ID.6c Categorize data as linear or not. Use algebraic methods and technology to fit a linear function to the data. Use the function to predict values.</p>
Instructional Expectations	
<p>In the traditional pathway, Algebra I students take a more sophisticated look at using a linear function to model the relationship between two numerical variables. In addition to fitting a line to data, students assess how well the model fits by analyzing residuals. S.ID.6b should be focused on linear models, but may be used to preview quadratic functions.</p> <p>In the international pathway, CCSS Mathematics I students take a more sophisticated look at using a linear function to model the relationship between two numerical variables. In addition to fitting a line to data, students assess how well the model fits by analyzing residuals. S.ID.6b should be focused on situations for which linear models are appropriate.</p>	

Interpreting Categorical and Quantitative Data		S.ID
Common Core Cluster		
Interpret linear models.		
Common Core Standard	Unpacking What does this standard mean that a student will know and be able to do?	
S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.	S.ID.7 Explain the meaning of the slope and y-intercept in context.	
S.ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.	S.ID.8 Use a calculator or computer to find the correlation coefficient for a linear association. Interpret the meaning of the value in the context of the data.	

<p>S.ID.9 Distinguish between correlation and causation.</p>	<p>S.ID.9 Explain the difference between correlation and causation.</p>
<p>Instructional Expectations</p>	
<p>In both pathways, the expectation in Algebra I and CCSS Mathematics I is to build on students' work with linear relationships in eighth grade and introduce the correlation coefficient. The focus here is on the computation and interpretation of the correlation coefficient as a measure of how well the data fit the relationship. The important distinction between a statistical relationship and a cause- and-effect relationship arises in S.ID.9.</p>	

<p>Making Inferences and Justifying Conclusions S.IC</p>	
<p>Common Core Cluster</p>	
<p>Understand and evaluate random processes underlying statistical experiments.</p>	
<p>Common Core Standard</p>	<p>Unpacking What does this standard mean that a student will know and be able to do?</p>
<p>S.IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.</p>	<p>S.IC.1 Explain in context the difference between values describing a population and a sample.</p>

<p>S.IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?</p>	<p>S.IC.2 Explain how well and why a sample represents the variable of interest from a population.</p> <p>S.IC.2 Demonstrate understanding of the different kinds of sampling methods.</p> <p>S.IC.2 Design simulations of random sampling: assign digits in appropriate proportions for events, carry out the simulation using random number generators and random number tables and explain the outcomes in context of the population and the known proportions.</p>
<p>Instructional Expectations</p>	
<p>In both pathways, the expectation in Algebra II and CCSS Mathematics III is that for S.IC.2, include comparing theoretical and empirical results to evaluate the effectiveness of a treatment.</p>	

<p>Making Inferences and Justifying Conclusions S.IC</p>	
<p>Common Core Cluster</p>	
<p>Make inferences and justify conclusions from sample surveys, experiments, and observational studies.</p>	
<p>Common Core Standard</p>	<p>Unpacking What does this standard mean that a student will know and be able to do?</p>
<p>S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.</p>	<p>S.IC.3 Identify situations as either sample survey, experiment, or observational study. Discuss the appropriateness of each one's use in contexts with limiting factors.</p> <p>S.IC.3 Design or evaluate sample surveys, experiments and observational studies with randomization. Discuss the importance of randomization in these processes.</p>

<p>S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.</p>	<p>S.IC.4 Use sample means and sample proportions to estimate population values.</p> <p>S.IC.4 Conduct simulations of random sampling to gather sample means and sample proportions. Explain what the results mean about variability in a population and use results to calculate margins of error for these estimates.</p>
<p>S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.</p>	<p>S.IC.5 Evaluate effectiveness and differences in two treatments based on data from randomized experiments. Explain in context.</p> <p>S.IC.5 Use simulations to generate data simulating application of two treatments. Use results to evaluate significance of differences.</p>
<p>S.IC.6 Evaluate reports based on data.</p>	<p>S.IC.6 Read and explain in context data from outside reports.</p>

Instructional Expectations

In both pathways, the expectation in **Algebra II** and **CCSS Mathematics III** is that in earlier grades, students are introduced to different ways of collecting data and use graphical displays and summary statistics to make comparisons. These ideas are revisited with a focus on how the way in which data is collected determines the scope and nature of the conclusions that can be drawn from that data. The concept of statistical significance is developed informally through simulation as meaning a result that is unlikely to have occurred solely as a result of random selection in sampling or random assignment in an experiment. For S.IC.4 and 5, focus on the variability of results from experiments—that is, focus on statistics as a way of dealing with, not eliminating, inherent randomness.

Conditional Probability and the Rules of Probability

S.CP

Common Core Cluster

Understand independence and conditional probability and use them to interpret data.

Common Core Standard	Unpacking What does this standard mean that a student will know and be able to do?
S.CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).	S.CP.1 Define a sample space and events within the sample space. Identify subsets from sample space given defined events, including unions, intersections and complements of events.
S.CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.	S.CP.2 Identify two events as independent or not. Explain properties of Independence and Conditional Probabilities in context and simple English.
S.CP.3 Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.	S.CP.3 Define and calculate conditional probabilities. Use the Multiplication Principal to decide if two events are independent and to calculate conditional probabilities.

<p>S.CP.4 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. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.</p>	<p>S.CP.4 Construct and interpret two-way frequency tables of data for two categorical variables. Calculate probabilities from the table. Use probabilities from the table to evaluate independence of two variables.</p>
<p>S.CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.</p>	<p>S.CP.5 Recognize and explain the concepts of independence and conditional probability in everyday situations.</p>
<p>Instructional Expectations</p>	
<p>In both pathways, the expectation in Geometry and CCSS Mathematics II is to build on work with two-way tables from Algebra I Unit 3 (S.ID.5) to develop understanding of conditional probability and independence.</p>	

Conditional Probability and the Rules of Probability

S.CP

Common Core Cluster

Use the rules of probability to compute probabilities of compound events in a uniform probability model.

Common Core Standard

Unpacking

What does this standard mean that a student will know and be able to do?

S.CP.6 Find the conditional probability of A given B as the fraction of B 's outcomes that also belong to A , and interpret the answer in terms of the model.

S.CP.6 Calculate conditional probabilities using the definition: “the conditional probability of A given B as the fraction of B 's outcomes that also belong to A ”. Interpret the probability in context.

S.CP.7 Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model.

S.CP.7 Identify two events as disjoint (mutually exclusive). Calculate probabilities using the Addition Rule. Interpret the probability in context.

<p>S.CP.8 (+) Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B A) = P(B)P(A B)$, and interpret the answer in terms of the model.</p>	<p>S.CP.8 Calculate probabilities using the General Multiplication Rule. Interpret in context.</p>
<p>S.CP.9 (+) Use permutations and combinations to compute probabilities of compound events and solve problems.</p>	<p>S.CP.9 Identify situations as appropriate for use of a permutation or combination to calculate probabilities. Use permutations and combinations in conjunction with other probability methods to calculate probabilities of compound events and solve problems.</p>

<h2 style="text-align: left;">Using Probability to Make Decisions</h2> S.MD	
<p>Common Core Cluster</p>	
<p>Calculate expected values and use them to solve problems.</p>	
<p>Common Core Standard</p>	<p>Unpacking What does this standard mean that a student will know and be able to do?</p>
<p>S.MD.1 (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.</p>	<p>S.MD.1 Understand what a random variable is and the properties of a random variable.</p> <p>S.MD.1 Given a probability situation (theoretical or empirical), be able to define a random variable, assign probabilities to it's sample space, create a table and graph of the distribution of the random variable.</p>

<p>S.MD.2 (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.</p>	<p>S.MD.2 Calculate and interpret in context the expected value of a random variable.</p>
<p>S.MD.3 (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.</p>	<p>S.MD.3 Develop a theoretical probability distribution and find the expected value.</p>
<p>S.MD.4 (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?</p>	<p>S.MD.4 Develop an empirical probability distribution and find the expected value.</p>

Common Core Cluster

Use probability to evaluate outcomes of decisions.

Common Core Standard	Unpacking What does this standard mean that a student will know and be able to do?
<p>S.MD.5 (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.</p> <ul style="list-style-type: none"> a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant. b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident. 	<p>S.MD.5 Set up a probability distribution for a random variable representing payoff values in a game of chance.</p>
<p>S.MD.6 (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).</p>	<p>S.MD.6 Make decisions based on expected values. Use expected values to compare long term benefits of several situations.</p>

S.MD.7 (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

S.MD.7 Explain in context decisions made based on expected values.

Instructional Expectations

In the **traditional pathway**, the **Geometry** expectation is that this sets the stage for work in Algebra II, where the ideas of statistical inference are introduced. Evaluating the risks associated with conclusions drawn from sample data (i.e. incomplete information) requires an understanding of probability concepts.

In the **international pathway**, **CCSS Mathematics II** students use this to set the stage for work in CCSS Mathematics III, where the ideas of statistical inference are introduced. Evaluating the risks associated with conclusions drawn from sample data (i.e. incomplete information) requires an understanding of probability concepts. Where CCSS Mathematics III students extend to more complex probability models. Include situations such as those involving quality control, or diagnostic tests that yields both false positive and false negative results.