Statistics
Content Standards
2022

Course Title:	Statistics
Course/Unit Credit:	1
Course Number:	439090
Teacher Licensure:	Please refer to the Course Code Management System (https://adedata.arkansas.gov/ccms/) for the most current licensure codes.
Grades:	9-12
Prerequisite:	Algebra I, Algebra II, or Quantitative Literacy

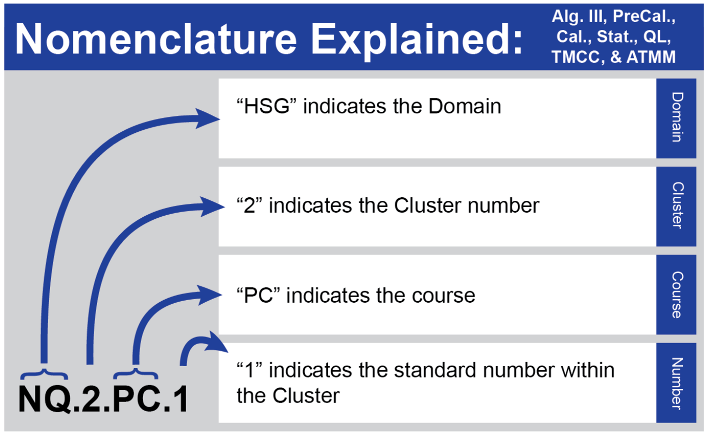
Course Description: Statistics is a two-semester survey course designed for students who have successfully completed Algebra II or Quantitative Literacy and expect to further their studies in business, social sciences, or education. Statistics builds on knowledge of probability, randomness, and variability to provide students with an understanding of experimental design, estimation, hypothesis testing, and effective communication of experimental results. Statistical information collected and analyzed by students is used to investigate ways of collecting, displaying, and analyzing data. An important distinction between this course and the AP Statistics courses is that this course is a survey of statistical processes and analyses.

Introduction to Secondary Arkansas Mathematics Standards

When the Division of Elementary and Secondary Education (DESE) began the process of revising math standards, a diverse group of qualified educators from across the state came together to craft Arkansas standards specific to the schools and students in the state. The result of this work, the Arkansas Mathematics Standards, is contained in this document. These standards reflect what educators across the state know to be best for Arkansas students.

Standards Organization: The revision committee maintained the organizational structure and nomenclature of the previous standards. Secondary Arkansas Mathematics Standards are categorized into domains, clusters, and standards.

- **Domains** represent the big ideas to be studied in each course and sometimes across grade bands. These big ideas support educators in determining the proper amount of focus and instructional time to be given to each of these topics.
- **Clusters** represent collections of standards grouped to help educators understand the building blocks of rich and meaningful instructional units. These units help students make connections within clusters and avoid seeing mathematics as a discrete list of skills they must master.
- **Standards** represent the foundational building blocks of math instruction. The standards outlined in this document work together to ensure that students are college and career ready and on track for success.



Standards Support: The revision of the Arkansas Mathematics Standards represent the work of the committee to provide greater clarity, strength, and support of the standards. Additionally, the revised mathematics standards are designed to help educators better understand the areas of emphasis and the focus within the standards. Educators should address the bulleted content as more than a checklist of items that they must teach individually. Content is bulleted to provide specificity of learning expectations included within some extensive standards. In some instances, the standard document includes Arkansas examples, teacher notes, specifications, and italicized words to assist educators with planning, teaching, and student learning.

- **Examples** included in the original standards were either changed for clarity or separated from the body of the actual standard. The examples included in the body of the standards document in no way reflect all of the possible examples. Likewise, these examples do not mandate curriculum or problem types. Local districts are free to select the high-quality curricula and instructional methods that best meet the needs of their students.
- **Teacher notes** offer clarification of the standards. These notes are intended to clarify, for teachers, what the expectations are for the learner. Likewise, these notes provide instructional guidance and limitations so that educators can better understand the scope of the standard. This will help with determining what is developmentally appropriate for students when working with specific standards.
- **Standard specifications** are to strengthen standards. The specifications are precise statements highlighting the need for mastery or function-type parameters for specific standards. This will assist educators in pinpointing the best opportunities for students to gain and master the knowledge and skills needed to succeed in a progression.
- **Asterisks (*)** are denoted to represent the modeling component of the standards. These standards should be presented in a modeling context which allows students to engage in the modeling process that is outlined in the Standards for Mathematical Process. (See Appendix A)
- **Italicized words** are defined in the glossary.

Finally, the Arkansas Mathematics Standards will be a living document. As these standards are implemented across schools in the state, DESE welcomes further suggestions related to notes of clarification, examples, professional development needs, and future revisions of the standards.

K - 12 Standards for Mathematical Practices	
1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics.*	5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.

Statistics	
Abbreviations: The following abbreviations are for the domains for the Arkansas Mathematics Standards.	
Making Inferences and Justifying Conclusions - IC	
	1. Make inferences and justify conclusions from sample surveys, experiments, and observational studies.
Conditional Probability and the Rules of Probability - CP	
	2. Understand independence and conditional probability and use them to interpret data.
	3. Use the rules of probability to compute probabilities of compound events.
Using Probability to Make Decisions - MD	
	4. Calculate expected values and use them to solve problems.
	5. Use probability to evaluate outcomes of decisions.

Making Inferences and Justifying Conclusions	
Cluster 1: Make inferences and justify conclusions from sample surveys, experiments, and observational studies.	
IC.1.S.1*	Use inference strategies to extrapolate on sample data. ● 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.* Teacher Note*: Simulations* with and without technology can be used to investigate the relationship between sample size and accuracy of *margin of error.*
IC.1.S.2*	Use data and simulation to compare multiple treatments in experimentation. ● Use data from a randomized experiment to compare two *treatments.* ● Use *simulations* to decide if differences between *parameters* are significant. Teacher Note: *Simulation* assumes no difference between the two treatments exists, which allows the data to be pooled together and then resampled into equal-sized samples as the initial experiment.

Conditional Probability and the Rules of Probability	
Cluster 2: Understand independence and conditional probability and use them to interpret data.	
CP.2.S.1	Describe events as subsets of a *sample space* using characteristics (or categories) of the outcomes, as unions, intersections, or complements of other events ("or," "and," "not").
CP.2.S.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.*
CP.2.S.3	Understand the *conditional probability* of A given B as P(A 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. Teacher Note: Students should use multiple models, such as tree diagrams, frequency tables, relative frequency tables, and shorthand notations, to analyze and interpret different conditional probabilities.
CP.2.S.4*	Demonstrate understanding of two-way table utilization. ● 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. Teacher Note: 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 given that the student is in the tenth grade and compare the results.

CP.2.S.5*	Recognize and explain the concepts of *conditional probability* and independence in everyday language and everyday situations. Teacher Note: 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.
Cluster 3: Use the rules of probability to compute probabilities of compound events.	
CP.3.S.1	Find the *conditional probability* of A given B, P(A|B), and interpret the answer in terms of the model (two-way frequency table, venn diagrams, etc).
CP.3.S.2	Apply the Addition Rule, P(A or B) = P(A) + P(B) - P(A and B), and interpret the answer in terms of the model.
CP.3.S.3	Apply the general Multiplication Rule in a *uniform probability model*, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.
CP.3.S.4	Use *permutations* and *combinations* to compute probabilities of *compound events* and solve problems.
CP.3.S.5	Use visual representations in counting (e.g. *combinations*, *permutations*) including but not limited to: • Venn Diagrams • Tree Diagrams

Using Probability to Make Decisions

Cluster 4: Calculate expected values and use them to solve problems.	
MD.4.S.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 used for *data distributions.* Teacher Note: Students should make connections between *probability distributions* and *data distribution*s.
MD.4.S.2	Calculate and interpret *expected value* of a random variable. • Calculate the *expected value* of a *random variable.* • Interpret the *expected value* of a *random variable* as the mean of the *probability distribution.* Teacher Note: Students should be able to interpret the *expected value* in the context of a problem to demonstrate understanding.
MD.4.S.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.* Teacher Note: 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.

MD.4.S.4*	Develop a *probability distribution* for a *random variable* defined for a *sample space* in which probabilities are assigned *empirically;* find the *expected value.* Teacher Note: 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?
Cluster 5: Use probability to evaluate outcomes of decisions.	
MD.5.S.1*	Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding *expected values.* ● Find the expected payoff for a game of chance. (Refer to first example). ● Evaluate and compare strategies on the basis of *expected values.* (Refer to second example*).* Teacher Note: Examples: ● Compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident. ● Find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.
MD.5.S.2*	Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). Teacher Note: To ensure random processes are fair, each experimental or observational unit must have an equal chance of being selected.
MD.5.S.3*	Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a soccer goalie at the end of a game).

Glossary

Combinations	A way of selecting items from a set or collection, such that the order of selection does not matter.
Conditional probability	The probability of an even (A), given that another (B) has already occurred; $P(A \mid B) = \frac{P(A \cap B)}{P(B)}$
Data Distributions	A graphical representation that specifies all possible values for a variable and also quantifies the frequency or relative frequency (or probability of how often they occur).
Empirical probability	The ratio of the number of outcomes in which a specified even occurs to the total number of tries (actual experiment)
Expected value	The mean of a probability distribution; $\mu = \sum xP(x)$
Independent event	Two events are independent if the occurrence or nonoccurrence of one does not change the probability that the other will occur; *P(A and B) = P(A)·P(B)*
Margin of error	Expresses the maximum expected difference between the true population parameter and a sample estimate of that parameter
Parameter	A numerical summary about a population.
Permutation	A way of selecting items from a set or collection, such that the order of selection does matter.
Population mean	Calculating a *sample mean* in an attempt to estimate a population you do not know; $\mu = \frac{\sum x}{N} = \frac{x_1 + x_2 + x_3 + \ldots + x_N}{N}$
Probability distribution	A table or an equation that links each outcome of a statistical experiment with its probability of occurrence
Random sampling	A procedure for sampling from a population in which the selection of a sample unit is based on chance and every element of the population has a known, non-zero probability of being selected.
Random variable	When the value of a variable is the outcome of a statistical experiment
Sample mean	The average of *n* data points $\bar{x} = \frac{\sum x}{n} = \frac{x_1 + x_2 + x_3 + \ldots + x_n}{n}$
Sample space	A set of elements that represents all possible outcomes of a statistical experiment
Sample survey	A study that obtains data from a subset of a population, in order to estimate population attributes
Simulation	A way to model random events, with or without technology, such that simulated outcomes closely match real world outcomes.
Theoretical probability	The number of favorable outcomes divided by the number of possible outcomes
Treatment	A product or technique that researchers administer to the objects in an experiment.
Uniform Probability Model	A probability model which assigns equal probability to all outcomes.

Appendix A.

Mathematical Modeling Cycle

The basic modeling cycle is summarized in this diagram. It involves: (1) identifying variables in the situation and selecting those that represent essential features; (2) formulating a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables; (3) analyzing and performing operations on these relationships to draw conclusions; (4) interpreting the results of the mathematics in terms of the original situation; (5) validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable; (6) reporting on the conclusions and the reasoning behind them. Choices, assumptions, and approximations are present throughout this cycle.