**Roanoke Valley Governor’s School for Science and Technology**

**AP Statistics/MTH 245 Competency List**

(Last updated: June 2022)

**Course description for AP Statistics**:

According to College Board, AP Statistics is an introductory college-level statistics course that introduces students to the major concepts and tools for collecting, analyzing, and drawing conclusions from data. Students cultivate their understanding of statistics using technology, investigations, problem solving, and writing as they explore concepts like variation and distribution; patterns and uncertainty; and data-based predictions, decisions, and conclusions. Students are expected to obtain a qualifying score of 3, 4, or 5 on the AP Statistics exam at the end of this course.

According to Virginia Western Community College, Statistics I (MTH 245) presents an overview of statistics, including descriptive statistics, elementary probability, probability distributions, estimation, hypothesis testing, correlation, and linear regression.

This course is taught using best practices in gifted education. Each competency is aligned with

Hockett’s five principles of gifted education:

**Gifted Education Principles:**

( Hockett, J.A. (2009) “Curriculum for Highly Able Learners That Conforms to General Education and Gifted Education Quality Indicators.” *Journal of Education for the Gifted***.** Vol. 32, No. 3, p. 394-440)

1. High-quality curriculum for gifted learners uses a conceptual approach to organize or explore content that is discipline based and integrative.
2. High-quality curriculum for gifted learners pursues advanced levels of understanding beyond the general education curriculum through abstraction, depth, breadth, and complexity.
3. High-quality curriculum for gifted learners asks students to use processes and materials that approximate those of an expert, disciplinarian, or practicing professional.
4. High-quality curriculum for gifted learners emphasizes problems, products, and performances that are true to life, and outcomes that are transformational.
5. High-quality curriculum for gifted learners is flexible enough to accommodate self-directed learning fueled by student interests, adjustments for pacing, and variety.

*External standards from College Board and the Virginia Community College System were referenced when reviewing these competencies. To the right of each Enabling Objective is notation indicating alignment with external standards and a relative priority/proficiency rating from A (highest) to D (lowest).*

COMPETENCY I

**Explore Relationships for Analysis of One-Variable Data**

|  |  |
| --- | --- |
| *Enabling Objectives* | External Standard |
| 1. Statistics is a Story about Us – What Can We Learn from Data? | AP 1.1 |
| 1. Variables – Who, What (Categorical, Quantitative, or Ranked), When, Where, Why, and How? | AP 1.2  VCCS 1.1 |
| 1. Represent Categorical Variables with Tables and Graphs | AP 1.3 & 1.4 |
| 1. Represent a Quantitative Variable with Graphs | AP 1.5  VCCS 1.2 |
| 1. Describe the Distribution of a Quantitative Variable (Shape, Center, Spread, Unusual Data Points) | AP 1.6 |
| 1. Summarize Statistics for a Quantitative Variable (Mean & SD, and 5-Number Summary) | AP 1.7  VCCS 1.3 |
| 1. Graphical Representations of Summary Statistics | AP 1.8 |
| 1. Comparing Distributions of a Quantitative Variable | AP 1.9 |
| 1. Use the normal curve to find area under the curve using the mean and standard deviation | AP 1.10  VCCS 1.4 |
| 1. Given a variable that has the normal distribution with a stated mean and standard deviation, find a value given a proportion | AP 1.10  VCCS 1.4 |

COMPENTENCY II

**Explore Relationships for Analysis of Two or More Variables.**

|  |  |
| --- | --- |
| *Enabling Objectives* | External Standard |
| 1. Represent Two Categorical Variables Graphically | AP 2.2 |
| 1. Use Appropriate Statistics for Two Categorical Variables | AP 2.3 |
| 1. Represent the Relationship Between Two Quantitative Variables | AP 2.4 |
| 1. Calculate Correlation to Interpret Positive or Negative Association, Linear Patterns, and Outliers & Influential Points in Scatterplots. | AP 2.5  VCCS 6.1 |
| 1. Calculate the Least-Squares Regression Model for a Set of Data. | AP 2.6  VCCS 6.2 |
| 1. Use the Least-Squares Regression Line to Predict Values and be Cautious of Extrapolation | AP 2.8  VCCS 6.2 |
| 1. Determine how much of the Variation of One Variable can be Accounted for by the Straight-Line Relationship with Another Variable. | AP 2.8  VCCS 6.3 |
| 1. Recognize the Possible Influence of Outliers on the Least-Squares Regression Line of a Data Set. | AP 2.9 |
| 1. Calculate and Plot the Residuals of a Data Set to Interpret the Appropriate use of a Linear Model | AP 2.7 |
| 1. Understand that Correlation does not Imply a Cause-and-Effect Relationship. | AP 2.6 |
| 1. Analyze Departures from Linearity and Re-Express Data to Fit a Linear Model | AP 2.9 |
| 1. Use Multiple Regression to Calculate how Multiple Explanatory Variables Affect a Response Variable | *Exceeds Standards* |

COMPENTENCY III

**Design Surveys and Experiments for Collecting Data**

|  |  |
| --- | --- |
| *Enabling Objectives:* | External Standard |
|  |  |
| 1. Determine whether a study is an observational study or an experiment. | AP 3.1  VCCS 2.3 |
| 1. Identify the population in a sampling situation | AP 3.2  VCCS 2.1 |
| 1. Use a table of random digits to select a random sample, stratified random sample, systematic random sample, and cluster random sample from a population | AP 3.3  VCCS 2.2 |
| 1. Recognize bias in certain sampling methods | AP 3.4 |
| 1. Recognize possible sources of error in a sample survey | AP 3.4 |
| 1. Carry out the random assignment of subjects to groups in a completely randomized experiment | AP 3.5 |
| 1. Compare Experimental Designs and Methods | AP 3.5  VCCS 2.4 |
| 1. Determine if causal relationship can be drawn from study | AP 3.7 |
| 1. Recognize possible sources of bias in an observational study or experiment | AP 3.6 |
| 1. Understand the placebo effect and recognize when a double-blind technique should be used | AP 3.6 |

COMPENTENCY IV

**Use Probability and Sampling Distributions to Draw Conclusions about the Population**

|  |  |
| --- | --- |
| *Enabling Objectives* | External Standard |
| 1. Estimate Probabilities using Simulations | AP 4.1 & 4.2  VCCS 3.1 |
| 1. Understand Elementary Probability Rules | AP 4.3, 4.4, 4.5, & 4.6  VCCS 3.1 & 3.3 |
| 1. Calculate probabilities for events and their complements. | AP 4.3  VCCS 3.3 |
| 1. Use the Law of Large Numbers to show that the Actual Observed Outcome Mean of a Large Number of Observations must Approach the Population Mean. | AP 4.3  VCCS 3.4 |
| 1. Use Bayes’ Rule to Calculate Conditional Probability Problems | *Exceeds Standards* |
| 1. Distinguish Between and Calculate Probabilities for Mutually Exclusive, Independent, Compound, and Conditional Events | AP 4.3, 4.4, 4.5, & 4.6  VCCS 3.2 |
| 1. Represent the probability distribution and calculate parameters for a discrete random variable and linear combinations for random variables | AP 4.7  VCCS 3.5 |
| 1. Calculate Probabilities and Determine Parameters for a Binomial Distribution | AP .10 & 4.11  VCCS 3.6 |
| 1. Calculate Probabilities and Determine Parameters for a Geometric Distribution | AP 4.12 |
| 1. Identify Parameters and Statistics in a Sample or Experiment. | AP 5.1 |
| 1. Determine the Appropriateness of using the Normal Distribution to Approximate Probabilities for Unknown Distributions | AP 5.2  VCCS 3.8 |
| 1. Estimate Sampling Distributions using Simulation to Investigate the Central Limit Theorem | AP 5.3  VCCS 3.7 & 3.10 |
| 1. Describe the Bias of a Statistic in terms of the Mean and Standard Error of its Sampling Distribution (i.e. Explain why an estimator is or is not unbiased) | AP 5.4 |
| 1. Determine Parameters of a Sampling Distribution for Sample Proportions and whether the Sampling Distribution is Approximately Normal | AP 5.5  VCCS 3.11 |
| 1. Use the Normal Approximation to Calculate Probabilities which involve the Sampling Distribution of One or Two Proportions | AP 5.6 |
| 1. Determine Parameters for a Sampling Distribution for Sample Mean with One or Two Samples | AP 5.7 & 5.8  VCCS 3.11 |
| 1. Understand that Variability of a Statistic is Controlled by the Size of the Sample | AP 5.5 & 5.7 |

COMPENTENCY V

**Make Estimations and Inferences about a Population using Categorial Data**

|  |  |
| --- | --- |
| *Enabling Objectives* | External Standard |
| 1. Identify Questions Suggested by Variation in the shapes of Distributions of Samples taken from the Same Population | AP 6.1 |
| 1. Verify the Conditions for, Calculate, and Interpret Confidence Intervals for a Population Proportion and Comparison of Population Proportions | AP 6.2, 6.3, & 6.8  VCCS 4.1  VCCS 4.3 & 5.1 |
| 1. Identify the Relationships Between Sample Size, Width of a Confidence Interval, Confidence Level, and Margin of Error for a Population Proportion and Comparison of Population Proportions | AP 6.2, 6.3, & 6.8  VCCS 4.2 |
| 1. Identify the Null and Alternative Hypotheses for a Population Proportion and Comparison of Population Proportions | AP 6.4  VCCS 4.5 & 5.1 |
| 1. Verify Conditions for, Calculate the Appropriate Test Statistic and p-value, for a Population Proportion and Comparison of Population Proportions | AP 6.4, 6.5 6.6, 6.9, 6.10, & 6.11  VCCS 4.6 & 5.1 |
| 1. Interpret the p-value of a Significance Test for a Population Proportion and Comparison of Population Proportions | AP 6.4, 6.5 6.6, 6.9, 6.10, & 6.11  VCCS 4.7, 4.9, & 5.1 |
| 1. Justify a Claim about the Population based on the Results of a Significance Test for a Population Proportion and Comparison of Population Proportions | AP 6.4, 6.5 6.6, 6.9, 6.10, & 6.11  VCCS 4.10 |
| 1. Calculate Minimum Sample Size given Confidence Level and Margin of Error | AP 6.2, 6.3, & 6.8 |
| 1. Identify, Calculate, and Interpret Type I and Type II Errors | AP 6.7  VCCS 4.8 |
| 1. Use Statistical Software to Verify & Interpret the Results of a Confidence Interval and Test of Significance for a Population Proportion and Comparison of Population Proportions (beyond AP) | VCCS 7.1, 7.2, & 7.3 |

COMPENTENCY VI

**Make Estimations and Inferences about a Population using Quantitative Data**

|  |  |
| --- | --- |
| *Enabling Objectives* | External Standard |
| 1. Identify Questions Suggested by Probabilities of Errors in Statistical Inference | AP 7.1 |
| 1. Describe t-Distributions | AP 7.2  VCCS 3.9 |
| 1. Verify the Conditions for, Calculate, and Interpret Confidence Intervals for a Population Mean, Difference Between Values in Matched Pairs, and Difference of Two-Population Means | AP 7.2, 7.3, 7.6, & 7.7  VCCS 4.1  VCCS 4.3, 5.2, & 5.3 |
| 1. Identify the Relationships Between Sample Size, Width of a Confidence Interval, Confidence Level, and Margin of Error for a Population Mean, Difference Between Values in Matched Pairs, and Difference of Two-Population Means | AP 7.2, 7.3, 7.6, & 7.7  VCCS 4.2 |
| 1. Identify the Null and Alternative Hypotheses for a Population Mean, Difference Between Values in Matched Pairs, and Difference of Two-Population Means | AP 7.4, 7.5 & 7.8  VCCS 4.5, 5.2, 5.3, & 5.4 |
| 1. Verify Conditions for, Calculate the Appropriate Test Statistic and p-value, for a Population Mean, Difference Between Values in Matched Pairs, and Difference of Two-Population Means | AP 7.4, 7.5, 7.7, 7.8, 7.9, & 7.10  VCCS 4.6, 5.2, 5.3, & 5.4 |
| 1. Interpret the p-value of a Significance Test for a Population Mean, Difference Between Values in Matched Pairs, and Difference of Two-Population Means | AP 7.4, 7.5, 7.7, 7.8, 7.9, & 7.10  VCCS 4.7, 4.9, 5.2, 5.3, & 5.4 |
| 1. Justify a Claim about the Population based on the Results of a Significance Test for a Population Mean, Difference Between Values in Matched Pairs, and Difference of Two-Population Means | AP 7.4, 7.5, 7.7, 7.8, 7.9, & 7.10  VCCS 4.10 |
| 1. Calculate Minimum Sample Size given Confidence Level, Standard Deviation, and Margin of Error | AP 7.2, 7.3, 7.6, & 7.7 |
| 1. Identify, Calculate, and Interpret Type I and Type II Errors | AP 7.5 & 7.9  VCCS 4.8 |
| 1. Use Statistical Software to Verify & Interpret the Results of a Confidence Interval and Test of Significance for the Population Mean, Difference Between Values in Matched Pairs, and Difference of Two-Population Means (beyond AP) | AP 7.10  VCCS 7.1, 7.2, & 7.3 |
| 1. Test the Hypothesis that More than Two Populations have Equal Means Against at Least One of Them Being Different Using ANOVA including Post-Hoc Analysis | *Exceeds Standards* |
| 1. Test Whether Two Factors have a Significant Effect on the Dependent Variable Using Two-Way ANOVA | *Exceeds Standards* |
| 1. Investigate Non-Parametric Tests for a Population Median, Difference Between Values in Matched Pairs, and Difference of Two-Population Medians when Parametric Tests are Not Appropriate | *Exceeds Standards* |

COMPENTENCY VII

**Use Categorical Data Involving Two-Way Tables and the Chi-Square Test to Examine Relationships Among Several Parameters**

|  |  |
| --- | --- |
| *Enabling Objectives* | External Standard |
| 1. Identify the Null and Alternative Hypotheses in a test for a distribution of proportions in a set of categorical data | AP 8.2 |
| 1. Verify Conditions for, Calculate Expected Values, Calculate the Appropriate Test Statistic, and p-value in a Test for a Distribution of Proportions in a Set of Categorical Data, for a Test of Homogeneity, and Independence | AP 8.2, 8.3, 8.4, 8.5, & 8.6 |
| 1. Interpret the p-value of a Significance Test in a test for a Distribution of Proportions in a set of Categorical Data, for a Test of Homogeneity, and Independence | AP 8.2, 8.3, 8.4, 8.5, & 8.6 |
| 1. Justify a Claim about the Population based on the Results of a Significance Test in a Test for a Distribution of Proportions in a Set of Categorical Data, for a Test of Homogeneity, and Independence | AP 8.2, 8.3, 8.4, 8.5, & 8.6 |
| 1. Use Statistical Software to Verify & Interpret the Results of a Confidence Interval and Test of Significance for a Distribution of Proportions in a Set of Categorical Data, for a Test of Homogeneity, and Independence | AP 8.7  VCCS 7.1, 7.2, & 7.3 |

COMPENTENCY VIII

**Use Statistical Estimation and Inference in the Regression Setting to Explain Relationships between an Explanatory Variable and a Response Variable**

|  |  |
| --- | --- |
| *Enabling Objectives* | External Standard |
| 1. Identify an Appropriate Confidence Interval Procedure for a Slope of a Regression Model | AP 9.1 |
| 1. Verify the Conditions, Calculate, Interpret, and Justify a Claim for Confidence Intervals for the Slope of a Regression Model | AP 9.2 & 9.3 |
| 1. Determine the Margin of Error for the Slope of a Regression Model | AP 9.2 & 9.3 |
| 1. Identify Appropriate Null and Alternative Hypotheses for a Slope of a Regression Model | AP 9.4 & 9.5  VCCS 6.4 |
| 1. Verify the Conditions, Calculate the Test Statistic & p-value, and Interpret Results for the Significance Test for the Slope of a Regression Model | AP 9.4 & 9.5  VCCS 6.4 |
| 1. Use Statistical Software to Verify & Interpret the Results of a Confidence Interval and Test of Significance for the Slope of a Regression Model | AP 9.6  VCCS 7.1, 7.2, & 7.3 |