Mathematical Design (+ G/T)
Essential Curriculum

Module 1 – Statistical Launch

a. Distinguish between categorical and quantitative variables. Recognize and generate statistical questions for each type of variable.
b. Construct bar charts, histograms, dot plots, boxplots, stemplots, and time plots.
c. Describe and interpret the overall pattern of each distribution by giving the center, spread, outliers, and shape.
d. Define and compute the mean, variance, and the standard deviation of a distribution.
e. Define and compute the median, quartiles, and the five-number summary.
f. Compare the mean and median of normal and skewed distributions.
g. State the properties of shape and symmetry of the normal distribution.
h. Calculate the *z*-value of the standard normal distribution given mean and standard deviation.
i. Use the graphing calculator and table to find the area under a curve, z values.

Module 2 – Exploring Categorical Data

a. Design a statistical question or questions that involve categorical data.
b. Identify the population in a sampling situation.
c. Identify and use sampling methods such as simple random or stratified random samples.
d. Recognize bias and sources of error in sample surveys.
e. Create and administer valid surveys to appropriate samples in order to collect data.
f. Identify parameters and statistics in a sample.
g. Calculate from sample counts the sample proportion or proportions that estimate the parameters of interest.
h. Construct and run a simulation using a graphing calculator or a computer.
i. Carry out a test of significance for the hypotheses that proportions are equal against a one-sided alternative by hand and using the graphing calculator.
j. Assess the statistical significance at standard levels.
k. Recognize that significance testing does not measure the size or importance of an effect.
l. Use decision analysis to determine potential Type I and Type II errors.
m. Compute the confidence interval for a population proportion *p* by hand and using the graphing calculator.
n. Define and interpret the meaning of "95% confidence" and other statements of confidence.
o. Understand the factors that affect the margin of error of a confidence interval.

Module 3 – Exploring Quantitative Data

a. Design a statistical question or questions that would involve means.
b. Identify the population in a sampling situation.
c. Identify the factors, treatments, response variables, and experimental units in an experiment.
d. Identify and use sampling methods such as simple random samples, stratified random samples, or matched pairs samples in order to select subjects and assign them to groups.
e. Diagram the design of a completely randomized experiment.
f. Design and run an experiment or observational study in order to collect quantitative data.
g. Calculate the z statistic and the P-value for one-sided tests about the mean m of a normal population by hand and using the graphing calculator.
h. Using the P-value, test the hypothesis that a population mean has a specified value against either a one-sided alternative.
i. Assess the statistical significance at standard levels.
j. Recognize that significance testing does not measure the size or importance of an effect.
k. Use decision analysis to determine potential Type I and Type II errors.
l. Define and interpret the meaning of "95% confidence" and other statements of confidence.
m. Calculate a confidence interval for the mean m by hand and using the graphing calculator.
n. Understand the factors that affect the margin of error of a confidence interval.

Module 4 – Exploring Bivariate Data

a. Recognize when a problem requires the comparison of explanatory and response variables.
b. Design a statistical question or questions that would involve bivariate data.
c. Collect bivariate data using statistically sound practices.
d. Construct a scatterplot to display the relation between two quantitative variables by hand and using the graphing calculator.
e. Interpret the direction, form, and strength of the association between variables.
f. Calculate the least-squares regression line, using a calculator, and interpret the slope and intercept. Use appropriate statistical notation.
g. Calculate and plot residuals to identify patterns of fit for linear and non-linear models by hand and in the graphing calculator.
h. Define and interpret the correlation coefficient r.
i. Fit linear and non-linear regression models to given and collected data.
j. State the limitations of correlation and regression by examining the effects of outliers or lurking variables.
k. Understand that a strong correlation does not imply a cause-and-effect relationship.
l. Appropriately use the regression equation to predict y for a given x.

m. Use r-squared (the coefficient of determination) to describe how much of the variation in one variable can be accounted for by a straight-line relationship with another variable.