Unit: Are Kitchen Cabinets at the Correct Height?

I. **UNIT OVERVIEW & PURPOSE:**

During this unit students will investigate the many aspects of the Normal Distribution using height data collected from females in the class. In the following six lesson plans students will compare normal data to data that is not normal; use percentiles and the Empirical Rule to make inferences about the height data; normalize the data using z scores; find various probabilities, regarding female height, using the area under the normal curve; discuss the need for the Central Limit Theorem; and apply the normal distribution to confidence intervals and hypothesis testing. By the end of the unit students will understand the "normal" range of female heights and then compare this to the height of kitchen cabinets. Finally, students will use the analysis of heights, and any other form of persuasion, to argue if kitchen cabinets should or should not be placed at a different height.

II. **UNIT AUTHORS:**

Lauren LaVenture and Brandon Taylor

Lord Botetourt High School

Botetourt County Public Schools

III. **COURSE:**

Mathematical Modeling: Capstone Course

IV. **CONTENT STRAND:**

Data Analysis and Probability

V. **OBJECTIVES:**

The student will:
- study the characteristics of normally distributed data
- analyze percentiles
- normalize data using z-scores
- use the area under the normal curve to find probabilities
- understand the Central Limit Theorem
- apply normal distributions to confidence intervals and hypothesis testing

VI. **MATHEMATICS PERFORMANCE EXPECTATION(s):**
- MPE 23: The student will analyze the normal distribution. Key concepts include:
    - a) characteristics of normally distributed data;
    - b) percentiles;
    - c) normalizing data, using z-scores; and
    - d) area under the standard normal curve and probability
- MPE 9: The student will design and conduct an experiment/survey. Key concepts include
    - a) sample size;
    - b) sampling technique;
    - c) controlling sources of bias and experimental error;
    - d) data collection; and

e) data analysis and reporting
- MPE 22: The student will analyze graphical displays of univariate data, including dotplots, stemplots, and histograms, to identify and describe patterns and departures from patterns, using central tendency, spread, clusters, gaps, and outliers. Appropriate technology will be used to create graphical displays.

VII. **CONTENT:**

Throughout this unit students will analyze what it means to be of "normal" female height. Students will collect their own data, discuss the data, and eventually find an acceptable range of female heights. Finally, students will use the results of analysis to debate whether the average height placement of kitchen cabinets should be changed.

VIII. **REFERENCE/RESOURCE MATERIALS:**
- Data collected from students: height, weight and shoe size
- Handouts for investigations (Follows each respective lesson as mentioned for the appropriate lessons)
- Class set of graphing calculators
- Optional: Microsoft Excel

IX. **PRIMARY ASSESSMENT STRATEGIES:**

Assessments will be in the form of:
- Short quizzes
- Writing – short answer and essay
- Final debate

All specific questions for the assessments are listed under the assessment section of each respective lesson

X. **EVALUATION CRITERIA:**
- Quizzes are graded on correctness – keys provided for each in the lessons
- Short answer and essay questions are graded on mathematical correctness and the use of certain information in the explanations – keys provided with suggested explanations
- The debate will be assessed on the preparation and argument presented by each group of students. There is no right or wrong side students simply need to use all available information to make and defend their case

XI. **INSTRUCTIONAL TIME:**

Regular Schedule: about 14 days
Block Schedule: about 7 days

Lesson 6: Culminating Activity and Wrap-Up

Strand
Data Analysis and Probability

Mathematical Objective(s)
During this lesson students will…

- estimate an interval for a given parameter (namely the mean for a population).
- discuss and understand the meaning of the p-value of a test of significance.
- use a confidence interval to determine whether sample is statistically significant.
- interpret the meaning of a test of significance in the context of the original problem.

Mathematics Performance Expectation(s)
- MPE 23: The student will analyze the normal distribution. Key concepts include:
  - a) characteristics of normally distributed data;
  - b) percentiles;
  - c) normalizing data, using z-scores; and
  - d) area under the standard normal curve and probability

Related SOL

- AII.11 (normal distribution)
- AFDA.7d (probabilities and the normal distribution)
- PS.16 (normal distribution)
- PS.18 (confidence intervals)
- PS.19 (test of significance)
- PS.20 (sampling distribution and the Central Limit Theorem)

All of these SOLs will be addressed in other lessons during this unit. The main focus of this particular lesson is AFDA.7d which is also mentioned in AII.11 and PS.16, 18, 19, and 20.

NCTM Standards
- understand how sample statistics reflect the values of population parameters and use sampling distributions as the basis for informal inference

Materials/Resources
- Classroom set of graphing calculators
- Height data collected from students

Assumption of Prior Knowledge
- It should be assumed that all students have a thorough knowledge and comprehensive understanding of the lessons that have been covered in this unit, how to conduct the

various tests that have been described, and state generalized conclusions based on those test results in the context of the original problem.

Introduction: Setting Up the Mathematical Task

Reflective Journal Entry

- To set up a background for this activity have students take out a piece of paper and answer the following in a narrative form:
- What were the results for the tests of significance for males and females?
- Explain these results in terms of the confidence intervals that you constructed earlier.
- Why do you feel that the average American cabinet height of 72 inches was chosen?
- Based on you alone, do you feel this height is appropriate?
- Consider someone else around you. Do you think this is an appropriate height? Why or why not?

Assessment

Whole Group Discussion:

Now, after students have written down their responses to the above journal entry, have the class separate themselves based on whether they think the chosen height of 72 inches is or is not appropriate.

- Using mathematical evidence, have each side argue why they feel the chosen height for cabinets is or is not appropriate. Students should justify their answers based on sample size, test of significance, etc.

Allow this activity to go back and forth so long as the discussion is relevant and well defined.

- Ask students why this is probably not the BEST way to conduct this test and consider a better way.
- When 72 inches was chosen as the average height for kitchen cabinets, what things were considered? Do you feel that they separated men and women when determining this number? What do you think the likely scenario was in this case?
- So, should the heights of kitchen cabinets be changed? Is this a different answer than what you wrote in your reflective journal entry?

Extensions and Connections

- Consider something else in our world or society in which an average is used as a baseline. Where do you think this number comes from? How do you think they got the

number they did? If students have difficulty with this, you may include something like par on a golf course or the number of laps for a NASCAR race depending on the track.

Strategies for Differentiation

- For students who do not participate actively in whole group discussions or debates, they should be able or allowed to justify their positions on the topic in a written fashion as opposed to the open debate.
- As an alternative to the in-class debate, students could create a PowerPoint presentation as a multistage process to comment on each section and create their own assessment material. It should be noted that students who know how to formulate and ask appropriate questions about the material likely know the material really well. Hence, a "self-absorbed" evaluation such as this may be a wonderful alternative.