Text: CORD Algebra
Volume: _____3_____ Chapter: ___1_____
Unit number: ___19__ Title of unit: Working with statistics
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We've got you pegged

Short Description (Be sure to include where in your unit this lab takes place):

Students will make cribbage board pegs from coat hanger wire in order to experience a manufacturing based application of the standard deviation measure. They will be introduced to the concept of statistical process control used in a modern manufacturing facility and see how statistics can be used to monitor production and for quality assurance. This lab is intended for use after students have had instruction in calculating mean and standard deviation using the statistics mode on their calculators.

LAB PLAN

TEACHER: *(Teacher Prep/Lab Plan)*

- **Lab Objective**
  - Review and practice measuring with a precision of +/- 1/32nd of an inch
  - Review and practice using a vernier caliper
  - Collect data on variations in the length of the pegs
  - Practice calculating standard deviation
  - Draw conclusions regarding tolerances for the pegs and other manufactured parts.
  - Determine the need for improvement in the manufacturing processes
  - Suggest changes to the manufacturing processes that will reduce variations in the lengths of the finished product

- **Statement of prerequisite skills needed***(Vocabulary, Measurement Techniques, Formulas, etc.)*
  - Measure in inches with a precision of +/- 1/32nd of an inch
  - Understand terminology (see vocab list)
  - Use side cutting pliers accurately
  - Use precision measuring tools (calipers and or micrometers)
  - Calculate mean and standard deviation on a calculator

- **Vocabulary**
  - Tolerance
  - Range
  - Standard deviation
  - Statistical process control
  - variability

- **State Standards addressed:** *(Highlight "Green" Standards, you may use your District's Power Standards if applicable)*
  - **Math:**
    - A.1.2.C Interpret and use integer exponents and square and cube roots….
    - A.1.6.A Use and evaluate the accuracy of summary statistics…
    - A.1.6.B Make valid inferences and draw conclusions based on data
    - A.1.8.G Synthesize information to draw conclusions…
    - All of the above are "Green Standards"
  - **Reading:**
  - **Writing:**
  - **Leadership:**
  - **SCAN Skills/Workplace Skills:**

- **Teacher Preparation:** *(What materials and set-up are required for this lesson?)*
  - Materials:
    - Metal (wire) coat hangers
      or other material with similar properties – 2 per group
    - Side cutting pliers or wire cutters – one per group
    - Vernier calipers – one per group
    - Rulers - one per group
    - Masking tape - 30" per group
    - Marking pens - black - fine point – one per group
    - Safety glasses – one per group minimum – for student doing cutting – preferably one pair for each student in the group
    - Calculator with Statistics functions – two per group
    - Data collection sheet – two per group

  - Set-Up Required:
    - Organize tools and materials into a "kit" for each group before class starts
    - Provide enough open table workspace for each group to perform tasks without interference from other groups or room furnishings
    - Cribbage board(s) with pegs as an example would be helpful
    - **Determine a specified length for the pegs that is <u>within the measurable range</u> of the precision measuring instrument(s) you will use

- **Lab Organizational Strategies:**
  - Grouping/Leadership/Presentation Opportunities:
    - Groups of 4 students with members determined in a manner of instructor's choice
    - Assign group management tasks and / or positions
    - Group presentation of lab results (Optional)
  - Cooperative Learning:
    - Reading and understanding of lab instructions
    - Performance of statistical calculations
    - Completion of lab report
  - Expectations:
    - On task throughout work time
    - All group members participating / contributing
  - Time-line:
    - 1 day – Hands on lab activities
    - ½ - 1 day lab report and presentation

- **Post Lab Follow-Up/Conclusions** *(to be covered after student completes lab)*
  - Discuss real world application of learning from lab:
    - Teacher presentation / video on Statistical Process Control
    - Lab team members discuss how standard deviation results could be used to set reasonable tolerances for product accuracy without changing manufacturing processes.
    - Lab team members discuss how changing manufacturing processes could improve standard deviation results in order to achieve more reasonable tolerances for product accuracy.

  - Career Applications:
    - Manufacturing Technician
    - Quality Assurance Inspector
    - Manufacturing Engineer

Additional resources and related information:

Mean difference measure compared to standard deviation

Both the standard deviation and the mean difference measure dispersion—how spread out are the values of a population or the probabilities of a distribution. The mean difference is not defined in terms of a specific measure of central tendency, whereas the standard deviation is defined in terms of the deviation from the arithmetic mean. Because the standard deviation squares its differences, it tends to give more weight to larger differences and less weight to smaller differences compared to the mean difference. When the arithmetic mean is finite, the mean difference will also be finite, even when the standard deviation is infinite. See the examples for some specific comparisons. The recently introduced distance standard deviation plays similar role than the mean difference but the distance standard deviation works with centered distances. ("Statistical Process Control in Manufacturing" Wikipedia 6-27-12)

Attach the Following Documents:

1. **Lab Instructions**
2. **Student Handout(s)**
3. **Rubric and/or Assessment Tool**

Your name:_____ Job_____
Group member's name:_____ Job_____
Group member's name:_____ Job_____
Group member's name:_____ Job_____

Your task is to form a manufacturing team to produce cribbage board pegs. The best team will be awarded a contract to produce one million pegs for which you will paid $.25 each (These are some really sweet cribbage pegs). You must produce them as quickly as possible without sacrificing the quality. Several teams will make a test run of 12 pegs on their production line. The contract will be awarded based upon how fast a team can produce the 12 pegs within a normal distribution for the accuracy of the lengths.

Instructions for completing this lab (Read steps 1 -10 first):

1. Write your name in the space above
2. Write your other group members' names in the spaces above
3. Select members to fill each of the following production jobs
    1. Layout – measures and marks the material for cutting
    2. Cutting – cuts the material to length according to layout
    3. Inspection – performs precision measurement of cut parts
    4. Data Collection – records measurements reported by inspector

4. Obtain the materials kit. Check to see that the following items are in it and in usable condition (Report any issues to instructor immediately)
    1. Metal (wire) coat hangers (2)
    2. Side cutting pliers or wire cutters – one
    3. Vernier calipers – one per group
    4. Ruler - one per group
    5. Masking tape - 30" per group
    6. Marking pens - black - fine point – one per group
    7. Safety glasses
    8. Data collection sheet -2

5. Do not begin working until the instructor gives the signal. Your team will be penalized for starting early.
6. Layout person marks 1-7/16" segments onto the hanger wire
7. Cutter cuts the wire on the marks as accurately as possible
    1. When all 12 pegs have been cut, Layout person writes the group's number on the white board in order of finish.
8. Inspector measures the length of each part to the nearest .001" and reports results to Data collector
9. Data collector records lengths on collection sheet
10. When Layout and Cutting have completed their jobs they work together to transcribe data onto a second data collection sheet

11. When both data sheets are complete, working in pairs, subtract 1-7/16" from each of the recorded finished lengths to determine the amount of variation from "spec".
12. Working in pairs, complete the two Data Collection Sheets by finding:
    The sum of the peg lengths,
    The mean peg length,
    The standard deviation for the peg lengths.
    Use your calculator to perform these calculations.
13. Compute the range of lengths for the mean length +/- 1 standard deviation
14. Compute the range of lengths for the mean length +/-2 standard deviations
15. As a group discuss whether you think using the mean +/- one std deviation is a reasonable tolerance for the length of this product.

Scoring Guide for this Lab:

All finished lengths recorded on both data sheets
All length variations calculated
Mean length is calculated
Standard Deviation is calculated
Mean length +/- one Standard Deviation is calculated
Mean length +/- two Standard Deviations is calculated
Brief explanation of whether or not using Mean length +/- one Standard Deviation is a reasonable way to set the tolerance of a precision product