Lesson Title	Statistical Analysis of Aircraft Incident Data
Length of Lesson	50 minutes
Created By	Emily Burtnett
Subject	Probability & Statistics
Grade Level	10^{th}, 11^{th},12th High School Topics
State Standards	5a
DOK Level	DOK 2
DOK Application	Describe the comparison of center and spread within groups and between or across group variation. (DOK 2)
National Standards	Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them. Select and use appropriate statistical methods to analyze them. Develop and evaluate inferences and predictions that are based on data. Understand and apply basic concepts of probability.
Graduate Research Element	Need for anti-ice coating for aerodynamic surfaces, motivation of research

Student Learning Goal:
Students are taught concepts and equations necessary to analyze data using statistics (mean/average, median, mode, range, standard deviation). The students will make future predictions based on trends. Recognize how to best describe a set of data using statistical analysis and ability apply it to a variety of data sets. Students will help students recognize patterns in the histogram they generate and the patterns will be further considered in a class discussion.

Materials Needed (supplies, hand-outs, resources):
Computers, Microsoft Excel, calculators, data hand-outs, notepaper

Lesson Performance Task/Assessment:
Students are given a set of data from aircraft crashes due to icing. Data includes ambient conditions, such as temperature, airspeed, and precipitation/weather conditions of each individual crash in the study. Students will either learn to use Excel or use prior knowledge of Excel to enter data and calculate various statistics. Using the calculated results and graphs, students will interpret the results and look for trends in the data. Students will be asked to record their thoughts and share their ideas. They will explain how and why they think they can predict typical icing conditions from their observations.

Lesson Relevance to Performance Task and Students:

This will give students a new perspective on the application of engineering in the real world. It will encourage students to use their mathematical ability to recognize trends and investigate new ways to analyze and interpret data.

Anticipatory Set/Capture Interest:
Capture students' attention with a video or pictures of an aircraft crash and/or the accumulation of ice accreting on an aerodynamic surface and asking them if they have any guesses as to why the aircraft crashed or what they think was accumulating on the aircraft wing. This will transition to a discussion of how statistics are prevalent to research by providing examples of interesting statistical facts that students can relate to, as well as statistics about aircraft icing.

Guided Practice:
The instructor will give a brief introduction to aircraft icing incidences that students may have seen on the news and explain that when a plane is sprayed down prior to take-off, this is an anti-ice coating to protect the wings from accumulating ice during flight. Some students may have experienced this themselves when flying commercial. The usefulness of statistics, especially for research purposes, will be introduced and will serve as the transition into a lecture on what the mean/average, median, mode, range, variance and standard deviation are and how they are calculated from a set of data. A few examples of these calculations from actual data (sample test scores, batting average of baseball players, etc.) will be demonstrated. Equations 1

$$mean = \frac{sum\ of\ values}{\#\ of\ values} \tag{1}$$

$$median = middle\ value \tag{2}$$

$$mode = most\ repeated\ value \tag{3}$$

$$range = largest\ value - smallest\ value \tag{4}$$

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2} \tag{5}$$

Where σ is the standard deviation, N is the number of values in the data set, x_i is a data value, and μ is the mean.

Students will be given the same data on aircraft accidents due to icing and asked to do a statistical analysis. Students will be guided through creating a histogram plot of the data, finding trendlines and understand the outlying data points.

After the students have completed their analysis and independent practice (see below) the instructor will guide the students through a discussion on their results and help to

discover how they can use their interpretations and results to predict the conditions where icing can occur.

Independent Practice:
Students will be allowed to do the data analysis mostly on their own, but will be given the opportunity to collaborate and share ideas with each other, as well. The students will be given free reign of Excel to not only interpret the data using their calculations, but to discover new ways to analyze the data with graphs. The students will be asked to discuss how the mean, median, mode, range and standard deviation describe the data and make conclusions. The students will be brought back together to partake in a mostly student led discussion with minor guidance and monitoring from the instructor to share their conclusions and results.

Remediation and/or Enrichment:
Some trends in the analysis will be more obvious to the students than others allowing for built in enrichment. Students will be allowed to experiment with plotting the data to look for trends. Possible remediation may be giving the students suggestions on what data to plot. Further enrichment may include expanding the data analysis to include normal distribution, percentiles, T-scores, Z-scores, as the instructor sees fit. Individual IEP's will be supported.

Check(s) for Understanding:
These questions can be asked to guide the students through their discussion.

1. Which statistic was most useful in predicting the conditions required for icing to occur?
2. Which statistic was the least useful in predicting the conditions required for icing to occur?
    a. Is there a case where this calculation might be more useful?
3. Was the plotting useful in visualizing trends? If so, why?
4. What are the predicted conditions required for icing to occur based on this analysis?

Closure:

1. Was there a particular set of data that "flawed" or skewed the results and may not have fit in with the rest of the data as well?
    a. Is it acceptable to disregard this data in a statistical analysis to obtain "better" results?
2. Why do you think it is important to continue research anti-ice coatings for aircraft surfaces and what other engineering/mathematical methods do you think would be useful in research?
3. Discuss other real world applications where statistical analysis can be beneficial.

Possible Alternate Subject Integrations:

Teacher Notes:
See attached Excel spreadsheet for sample data.
http://www.aopa.org/asf/publications/sa11.pdf
http://c3vp.org/field/AVISA/AVISA.html
http://math.youngzones.org/stat_graph.html