Power Metering Project

Grades: 9-12

Topic: Energy Basics

Owner: ACTS

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Learning Goals

Stated Objectives

- Collect and analyze one-variable data
- Understand concept of electrical power
- Formulate appropriate questions and a path to answer those questions
- Use data logger to collect power data
- Use Excel/Logger Pro to manage data
- Apply one variable statistics to present an energy efficiency story/argument
- Use Excel/Logger Pro to create box plots, histograms, and time series charts

NCTM Standards

(Data Analysis and Probability Standard for Grades 9-12)

- understand the meaning of measurement data and categorical data, of univariate and bivariate data, and of the term variable;
- understand histograms, parallel box plots, and scatterplots and use them to display data;
- compute basic statistics and understand the distinction between a statistic and a parameter.
- for univariate measurement data, be able to display the distribution, describe its shape, and select and calculate summary statistics;
- recognize how linear transformations of univariate data affect shape, center, and spread;

Assessment Plan

In general, I follow a set pattern for communicating the material: (1) introducing a concept with an exploratory problem set, (2) providing 4-5 homework assignments, (3) reviewing, and (4) testing. I tailor the homework assignments to what we cover in class. If we do not reach a certain topic then I will modify the assignment. While I tend to slow down in my other classes, I try to stick with a rigid pace in this AP class.

Table 1: Assessment Plan

Assessment Type	Learning Objectives	Format of Assessment	Modifications
Pre-Assessment	-discover prior knowledge of statistics	-in class activity and worksheet	
Formative Assessment 1	-distinguish between categorical and quantitative variables -explain the who, what, and why of a data set -understand the uses of bar charts and pie charts and create both -construct a stemplot and recognize its value	HW: 1.2, 4, 5, 10	
Formative Assessment 2	-construct a histogram by hand and using TI-84 -describe a distribution	HW: 1.12, 13, 15, 19, 29	

	-construct a relative frequency graph using TI-84		
Formative Assessment 3	-calculate and evaluate the properties of mean and median -compute quartiles and construct boxplots -compute numerical summaries	HW: 1.31-4, 36	
Formative Assessment 4	-calculate standard deviation -describe spread -perform/interpret linear transformations -compare distributions	HW: 1.41,43,45,48	
Formative Assessment 5	-collect power data using logger -input data into Excel -display data numerically and graphically -make a practical conclusion based on statistics	Project-collect power data and use one-variable statistics to analyze	
Post-Assessment	-review for chapter test -assess mastery of chapter 1	-Review packet -Test	

Implementation Design

I taught each section of this course with the same general format mentioned in the *Assessment Plan* section: (1) exploratory problem set, (2) lectures followed with problem sets, (3) review sheets, (4) test. The implementation design table (Table 2) refers to the assignments listed in the assessment plan table (Table 1).

Table 2: Implementation Design

Instructional Activity	Learning Objectives	Resources	Timeframe	Assessment
A. Introduction Pre-Assessment	-introduction to statistics -discover prior knowledge of statistics	*Yates, Moore, Starnes*	1 day	Pre-Assessment
B. Displaying Distributions with Graphs	-learn appropriate graphical displays for different data sets -understand, create, and use stemplots, histograms, pie charts, cumulative frequency charts, boxplots, and bar charts -apply knowledge to practical problem of energy efficiency in the classroom	*Yates, Moore, Starnes* Handout (see section)	2 days	Formative Assessments 1, 2, and 5
C. Displaying Distributions with Numbers	-understand five number summary and explain how/when to use measures of center and measures of spread -be able to calculate standard deviation and variance (understand their relationship) -apply linear transformations to data sets to achieve unit of measurement changes -apply knowledge to practical problem of energy efficiency in the classroom	*Yates, Moore, Starnes* Handout (see section)	2 days	Formative Assessments 3, 4, and 5
D. Review/Test	-Review chapter for test.	*Yates, Moore,*	2 days	Review packet

	-Assess mastery of chapter 1	*Starnes*		Test 1

The lectures are sequenced according to the text. Technology is incorporated via the TI-84 calculator and computers with Excel and Logger Pro. I use the TI Smartview program to project a TI-84 plus calculator onto the screen via an LCD projector. This program allows students to see my keystroke history and easily follow the steps of the program.

Handout (Power Metering Project)

Objective: Apply your knowledge of graphical and numerical data analysis and display to the practical problem of energy conservation. Learn the basics of power metering and subsequent data analysis.

Background: There are many devices around campus that use electricity, but it helps to have an understanding of how much power each type of device uses. With this information, you are better able to focus efforts on reducing power consumption. With basic power data collection and analysis, we can begin to answer questions like: how much money does it cost the school to leave all the computers on at night?

Format: You will submit both a written report and your Excel spreadsheet file. The written report should include the charts that you create in Excel. The report should be typed and follow the numbered format of the assignment.

Assignment: You will be assigned to a group for this project.

1.) Choose a question related to the cost of power that you want to answer. Some suggestions are given below (in addition to the one mentioned above), but I encourage you to come up with your own questions.
   a. How much does it cost to charge the 30 laptops each night?
   b. How much does it cost if we forget to turn off the air conditioning units in the computer lab and fan room at night?
   c. What is the cost associated with the standby power consumption of typical classroom electronics? (VCRs, DVD players, LCD projectors, etc.)
   d. How much does it cost to keep our water fountains running all the time?

2.) Make a guess about the answer to your question. Submit this guess to me.

3.) Meet with me to schedule a time for your group to use the power meter to collect data. The due date of the assignment will vary according to when you start collecting data. You will need to collect at least two sampling periods. Your sampling periods will vary according to the question you are trying to answer. For example, in question (a), your sampling period would be from 9pm to 8am (overnight). You would collect data for two nights to record two sampling periods worth of data.

4.) Once you have collected the data, you will use the laptops to input the data into Excel (I will give a presentation to the class that will explain how to do this step).

5.) Provide summary statistics for your data set

a. five number summary
b. boxplot
c. time series chart (power vs. time)
d. standard deviation

6.) Decide on a reasonable average power measure and time period to convert to cost of electricity. Assume that electricity costs $0.08/KW-hr. For example, if the laptop cart uses an average of 300 W of electricity at night for 10 hours, then it costs $3.00 a night to charge the laptops. (How does that figure compare to gas prices?)

7.) Answer these questions:
a. How do your results in (6) compare to your guess in (2)?
b. Is mean an appropriate estimate for extended power consumption? Is there a more accurate way to answer your original question? If yes, what method do you propose?
c. What did you learn about the time-sensitivity of power consumption?
d. Were you surprised by your results? Why or why not?

8.) Make some energy conservation recommendations based on your project that the school could implement easily.