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Statistics Mentoring for Mass Academy Students

An Interactive Qualifying Project

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By

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Abstract

Each year students at the Massachusetts Academy of Mathematics and Science compete in a science fair. In recent years, it had been observed that several student projects lacked proper statistical design and data analysis. The goal of this project was to help improve the overall quality of the science fair projects by introducing the students to the fundamental concepts of statistical design through activities and individual mentoring.

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1. Introduction

The Massachusetts Academy of Mathematics and Science is a special public high school for juniors and seniors. These students are advanced in mathematics and science and attend the Academy for an accelerated and concentrated approach to learning in math and science. The school has a unique curriculum based on collaborative learning, problem solving and research. It is a collaborative effort between the Commonwealth of Massachusetts, Worcester Polytechnic Institute, and the high schools of Massachusetts. The students and the faculty of the Academy work closely together to encourage individual intellectual growth.

Every year at Massachusetts Academy of Mathematics and Science juniors compete in a science fair. They begin this project over the summer. First they think of a research question and begin brainstorming. In August they have class time set aside for research and development of their project. From November to December they start collecting data. Finally in February they present their projects in the science fair.

The IQP is geared to improve the students' science fair projects by adding a statistical approach to design and analysis. The initial motivation for this project was that judges in past years had commented on lack of analysis and sometimes poor design. Our objective is to mentor the students in statistics and help improve the quality of their projects.

At the outset of the project the IQP group had several goals in mind to properly mentor the students of Massachusetts Academy of Mathematics and Science by adding a statistical component to the student's science fair projects.

Our goals were as follows:

1. To evaluate the eleventh grade students' current statistical background

   In order to evaluate the students' current background, the project group met with the junior class's math teacher and discussed the students' current statistical background. Most students had no prior instruction in statistics.

2. To present all students in the junior class with an introduction to statistics.

   In order to give an introduction to statistics to the junior class, an experiment was conducted in class with the whole junior class present using chocolate chip cookies. The IQP group had the students count the number of chocolate chips in two different brands of cookies and generated data to display concepts such as sampling, variation, and control. The project group concluded this activity by performing a t-test to compare the number of chocolate chips in two brands of chocolate chip cookies. This activity and presentation are described in detail in Section 3.2.

3. To determine the selected students in the junior class that will need a more comprehensive background in statistics.

In order to determine which students would need more background in statistics, the IQP project group had each student in the junior class fill out an index card with their initial project title and description. The cards were reviewed and then it was determined which students would fit best into our mentoring project. As the descriptions were brief, we provided the students that we believed would benefit the most from statistical knowledge in regards to their science fair projects with a more comprehensive survey. The students filled out the surveys and were selected or declined for mentoring based on the surveys. For example, a student who was doing an engineering project, that would spend a great deal of time in development, or a project based primarily on qualitative data they were not selected. For the most part, pure science projects that would yield hard data were selected.

4. Work closely with selected students who had pure science projects to give them appropriate knowledge for their specific projects.

In order to achieve this goal the IQP group met with the selected students and asked them questions based on the information filled out in the surveys that were provided. The mentors of the IQP group discussed their projects in length and gave them advice on how to perform their various experiments with a good statistical design in mind. The IQP group gave another presentation to these selected students. This presentation involved a cup flipping activity and was conducted to emphasize concepts such as variability and confounding. This

activity is described in detail in Section 3.3. The IQP group met with the students and discussed their projects once they had begun collecting data to get updates on project changes and give further advice.

5. To develop a statistical handbook that could be used for science fair projects at the Academy or other schools in future years.

   This goal was not completed due to difficulties in meeting with the students on a regular basis. The Mass Academy works on a rotating schedule that was not always conducive to regular meetings. Also the deadline for the science fair projects was too close to the deadline for the IQP project. The students mentoring took precedence and it was not feasible to fully develop a generic handbook to be used for future science fair projects. A recommendation for a future IQP project would be to run into D term to allow for time after the students had gone through the judging phase of their projects. However this handbook would be written based on the concepts in Chapters 2 and 3.

   This IQP includes a chapter on concepts written with the needs of a science fair project in mind and an activities section describing presentations and activities presented to the eleventh grade students. It also includes in-depth case studies for each student.

2. Fundamental Concepts of Statistics

2.1 Introduction

The purpose of this project is to teach the students a statistical approach to designing their experiments and analyzing their data. Some concepts that will be necessary for good experimental design and data analysis are:

- Randomization
- Replication
- Control
- Sampling and Populations
- Variance
- Data Analysis

2.2 Basic Concepts

Some basic concepts that were thought to be necessary to discuss with the students were sampling, populations, and variation. These are important to understand in order to be able to comprehend the analysis of the data.

Sample:

A sample is simply a unit on which measurements or observations can be made.

Population:

The collection of all samples from which conclusions can be drawn.

Sampling Variability:

Between Variation: Difference in results from one group of data to the next.

Within Variation: Difference in the results inside one group of data.

2.3 Fundamentals of Experimental Design

2.3.1 Introduction

It is important to design an experiment which enables the testing of the hypothesis. The design must include principles of conducting the experiment and collecting data in a feasible way. Often a design will not be perfect and will have to be amended or corrected to allow for changes in the experiment. Three important concepts to understand in experimental design are randomization, replication, and control.

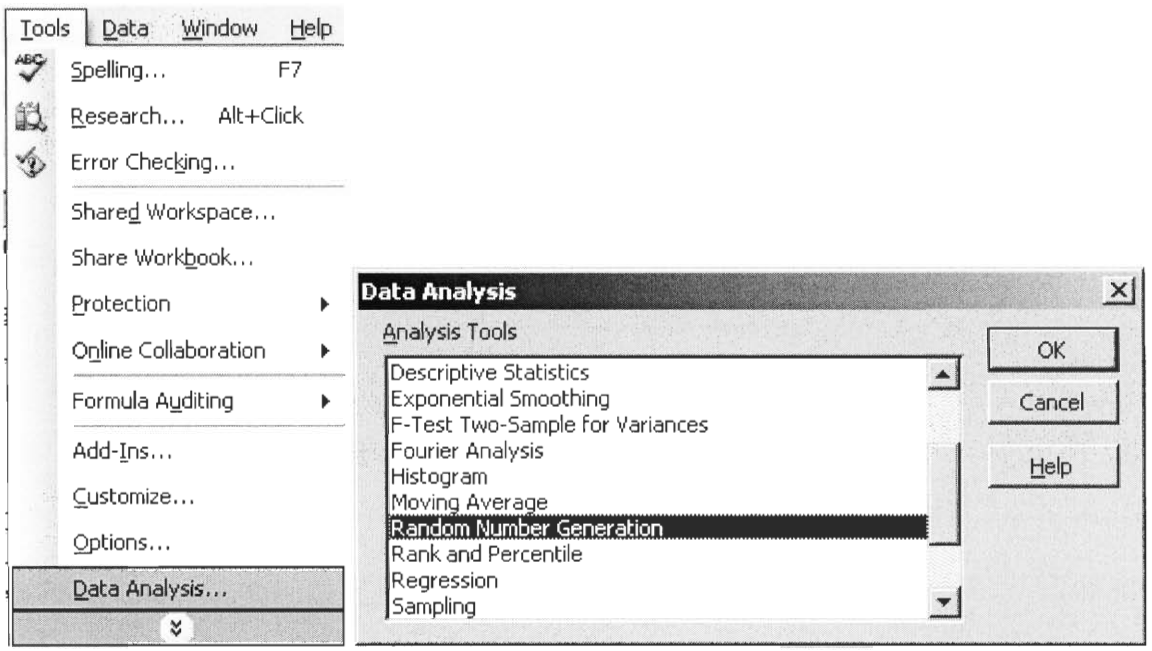
2.3.2 Randomization

Randomization is the chance assignment of treatments to experimental units in order to nullify the effects of unsuspected nuisance factors. It is important to use chance to assign subjects to their respective groups, for minimization of bias that can be present in samples. Randomization can be used in assigning different populations to their treatments; the type of treatments given to a population or the order of treatments the population is given.

The use of a computer or a table of random digits can achieve randomization. Randomization will ensure the chance of each subject being assigned to a condition is the same. If randomization is not used then certain biases or confounding variables can occur. Bias can occur very easily if randomization is not used. For example, if the order of treatments is the same throughout the example there may be certain things a subject will learn that will affect each following treatment. If the treatments are assigned in a random order, then the possibility of bias will be eliminated. Another example would be to assign the populations that will receive certain treatments but not others randomly. This will eliminate the possibility of certain biases within a population.

To assist in randomization, random numbers can be generated in Microsoft Excel. Select **Data Analysis** from the **Tools** menu and then **Random Number Generator** from the menu (See Figure 2.1). If Data Analysis is not available from the Tools menu, the add-in must be installed (See instructions in Section 3.2 and Figure 3.7).

Figure 2.1: Random Number Generator



2.3.3 Replication

Replication is simply the repetition of each treatment in an experiment. It is a simple concept to understand; the number of observations collected is directly associated with the accuracy of the conclusions that can be drawn. Replication will show the more subtle differences in the response to each treatment. Also, replication allows for an easier assignment of the size of experimental error. The size of replication for each experiment can be decided by looking at the necessary precision of an experiment, and the time and budget constraints inherent in the experiment.

If replication is not performed or not performed on a large enough scale to suite the experiment it is difficult to be certain of the accuracy of the conclusions. Results must be replicated in order to confirm them.

2.3.4 Control

Control is defined as the effects of lurking variables on the response, which can be seen by comparing several treatments. It is important to use control groups in experiments to have something to gauge the response of the variable being tested. For example, in testing the result of a drug an experimenter would use a control group that is treated exactly the same as all other groups but instead of the active drug, they are given a placebo. This group's response can be compared to the other populations to gauge the response of the drug and determine whether its effects are due to the presence of the drug.

In the absence of control the experimenter will not be sure if the responses to their experiment are due to the treatments. The control group gives validity to the other responses collected.

2.4 Analysis

2.4.1 Introduction

Analysis of data is the final step in the science fair projects. Analysis is important in any project to bring meaning and organization to the data collected. Without analysis collected data can seem chaotic and confusing. The students used different tests depending on what was appropriate to their project. Certain tests were performed depending on number of samples, variation, population size and the type of data taken. Described in this section are the analysis tests different students used to discover the significance of the data they had collected, including a t-test, F-test, regression model, and a Cochran Armitage test.

2.4.2 t-test

The t-test is a test that is used to determine if there is a significant difference between two populations. The first thing that must be done to perform a t-test is to form hypotheses, the alternative and the null hypothesis. The alternative hypothesis is the theory that will be tested and the null hypothesis is the opposite. For example, in the Cookie Activity in section 3.2, the alternative hypothesis is that the cookies have different amounts of chocolate chips in them, while the null hypothesis is that the cookies have the same amount of chocolate chips in them.

Once all of the data have been collected they must then be analyzed. To perform a t-test, the means of the two different groups must be calculated along with the variability between the groups. The level of significance must be determined beforehand and that value is a reference in the t table, a list of all t values. Along one axis of the

table are the degrees of freedom and along the other axis is the confidence level. With these two numbers the acceptable value can be determined. That number is then compared to the test statistic, which is found by dividing the difference between the groups' means and the variability of the groups. If the test statistic is larger than the value computed from the table then the null hypothesis can be rejected and the difference between the data is said to be statistically significant.

The t-test can be performed using Microsoft Excel. For instructions on how to do this, refer to the Cookie Activity analysis (Section 3.2 and Figure 3.6).

2.4.3 F-test

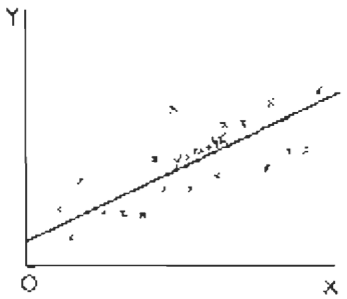
This test is used to determine whether there is a significant difference between any pair from among several group means. The test statistic is the so called F statistic, which is a ratio of between-group variation to within-group variation. If the null hypothesis that all group means are the same is true, then the F-ratio should be relatively small. If the F-ratio is relatively large, this is evidence that the null hypothesis is false. As with the t-test, the F-test can also be performed using Microsoft Excel.

2.4.4 Regression

Regression analysis is used to estimate quantitative functional relationships between dependent variables and one or more independent causal variables from observed data when the relationship among the variables is statistical in nature. By a statistical relationship it is meant that the dependent variable's observed values are generated by a probability distribution that is a function of other causal variables. Empirical investigation of the relationships among different variables requires the tools

of statistical inference, including regression analysis. This can be used to predict future performance or to display the trend of a series of the data. Graphically, it can be displayed on a scatter plot where points (x, y) are plotted from the data throughout the graph and a line is generated through those points to show the trend (See Figure 2.1). This test can also be performed in data sets in Microsoft Excel. Please refer to the similar instructions for the t-test above.

Figure 2.2: Regression Analysis



2.4.5 Cochran-Armitage test

This test is used to find evidence of an increasing or decreasing trend in binomial proportions. It is appropriate for a contingency table where one variable has two levels and the other variable is ordinal. The two-level variable represents the response, and the other variable represents an explanatory variable with ordered levels. When the contingency table has two columns and *R* rows, it tests for trend across the *R* levels of the row variable, and the binomial proportion is computed as the proportion of observations in the first column. When the table has two rows and *C* columns, it tests for trend across the *C* levels of the column variable, and the binomial proportion is computed as the proportion of observations in the first row. In other words, it looks for a trend and determines how statistically significant the data are. For example, when data have been

collected over time, it is apparent if there is a significant trend over that time. This test cannot be performed in Microsoft Excel, in order to do so, the aid of a more powerful statistical analysis software, such as SAS, will be required. Some SAS code can be found in Section 4.2.4 under Table 4.3.

3. Activities

3.1 Introduction

Over the course of the project, the students of Mass Academy participated in two activities. The purposes of these activities were to involve the students and force them to participate and make them think about their projects and how the activities could relate to their own projects.

The first activity took place in mid-September and all of the juniors were present. This activity involved the basic concepts of statistics, population, sampling, and variance. The students were shown how Microsoft Excel could be used for statistical analysis.

For the second activity the group was narrowed down. It was determined that this activity would be beneficial to the students who were being mentored and the others would not learn anything useful for their project. The main goal of this activity was to explain and demonstrate the importance of randomization.

3.2 Cookie Activity

Objective: To outline some basics concepts of statistics and to demonstrate a few of the common ways to summarize data. This presentation will cover populations, sampling, and variance. The activity will be an experiment counting chocolate chips in cookies and analyzing the data.

Materials

- Chocolate Chip Cookies
  - 2 kinds (i.e. one Chips Ahoy and one Generic)
- Microsoft PowerPoint Presentation
- Microsoft Excel Spreadsheet for collecting data

Procedure:

1. Initial Presentation
   a. Open PowerPoint presentation and briefly describe the goal of the presentation.
   b. Run through each slide and discuss the importance of the topics on them,
   c. Continue until the Experiment Slide.
2. Experiment
   a. Divide the class in half.
   b. Distribute 2 Chips Ahoy cookies to the first group of students.
   c. Distribute 2 Generic Chocolate Chip cookies to the second group of students.
   d. Have the students count the chocolate chips from each cookie in any manner than they wish. Make sure they record the results.
   e. Enter the data from each student into an Excel spreadsheet in four separate columns (two for the two Chips Ahoy trials and two for the Generic trials).
   f. Sort the data in each column from highest to lowest. (see Figure 3.1)

Figure 3.1: Sample Data

	A	B	C	D	E	F	G	H	I	J	K	L
1		Chips Ahoy			Chips Ahoy			Generic Cookies			Generic Cookies	
2	Number	CA Sample1	Sorted		CA Sample2	Sorted		G Sample1	Sorted		G Sample2	Sorted
3	1	8	8		13	8		15	10		17	10
4	2	12	8		18	8		32	10		16	11
5	3	9	9		8	9		17	10		11	11
6	4	15	9		10	9		13	12		21	11
7	5	20	10		23	10		18	13		16	13
8	6	13	10		10	10		24	13		14	13
9	7	10	11		15	11		10	14		28	13
10	8	12	12		16	11		19	14		13	14
11	9	19	12		11	12		14	15		22	15
12	10	25	12		18	12		15	15		17	15
13	11	17	13		13	13		18	16		31	16
14	12	11	13		9	13		15	16		24	16
15	13	14	13		24	13		14	17		16	16
16	14	18	14		12	13		17	17		15	16
17	15	8	15		17	15		22	17		18	17
18	16	12	15		11	16		18	18		11	17
19	17	15	16		20	17		16	18		24	17
20	18	13	17		13	17		29	18		13	18
21	19	22	18		17	17		10	18		16	21
22	20	20	18		8	18		16	19		11	22
23	21	13	19		13	18		25	22		26	24
24	22	18	20		17	20		18	24		10	24
25	23	10	20		24	23		13	25		17	26
26	24	9	22		12	24		12	29		15	28
27	25	16	25		9	24		17	32		13	31
28												
29	sample mean	14.36			14.44			17.58			17.40	
30	sample std dev.	4.58			4.83			5.48			5.63	

3. Analysis
    a. Return to the PowerPoint presentation to discuss the analysis slides.
    b. For every slide that introduces a new topic, return to the excel spreadsheet to give an example. Topics to be covered include: Mean, Standard Deviation, Histogram, and a T-test.
    c. At the end of the analysis, conclude by giving a Summary of the presentation and entertain questions.

- Mean: In order to calculate the mean of a sample population, type **'=AVERAGE('** into one of the cells. Then drag the mouse cursor from the first cell in the range of samples to the last (either top to bottom or left to right, however the table is formatted). Close the parentheses and hit Enter to finish the calculation (see Figure 3.2).

- Standard Deviation: To calculate the standard deviation, complete the same process as for the mean but by entering '**=STDEV(**' into a cell (see Figure 3.3).

- Data Analysis: In order to produce a histogram or t-test select **Data Analysis** from the **Tools** menu. Select the desired tool from the list and hit **OK** (see Figure 3.4).

- Histogram: select **Input Range**, hit **OK**. Then select the output and Chart it into columns using the **chart**  **button** from the **Formatting Toolbar** (See Figure 3.5.)

- t-test: Fill the values from 2 different sample ranges and hit **OK** (see Figure 3.6).

Figure 3.2 - Sample Mean:

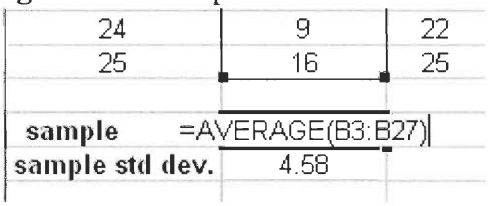


Figure 3.3 - Sample Standard Deviation:

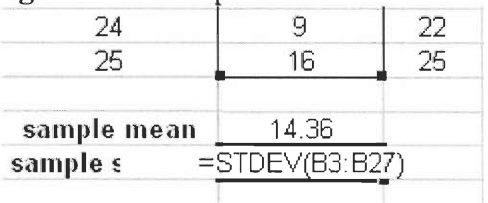


Figure 3.4 - Data Analysis Package: in Excel

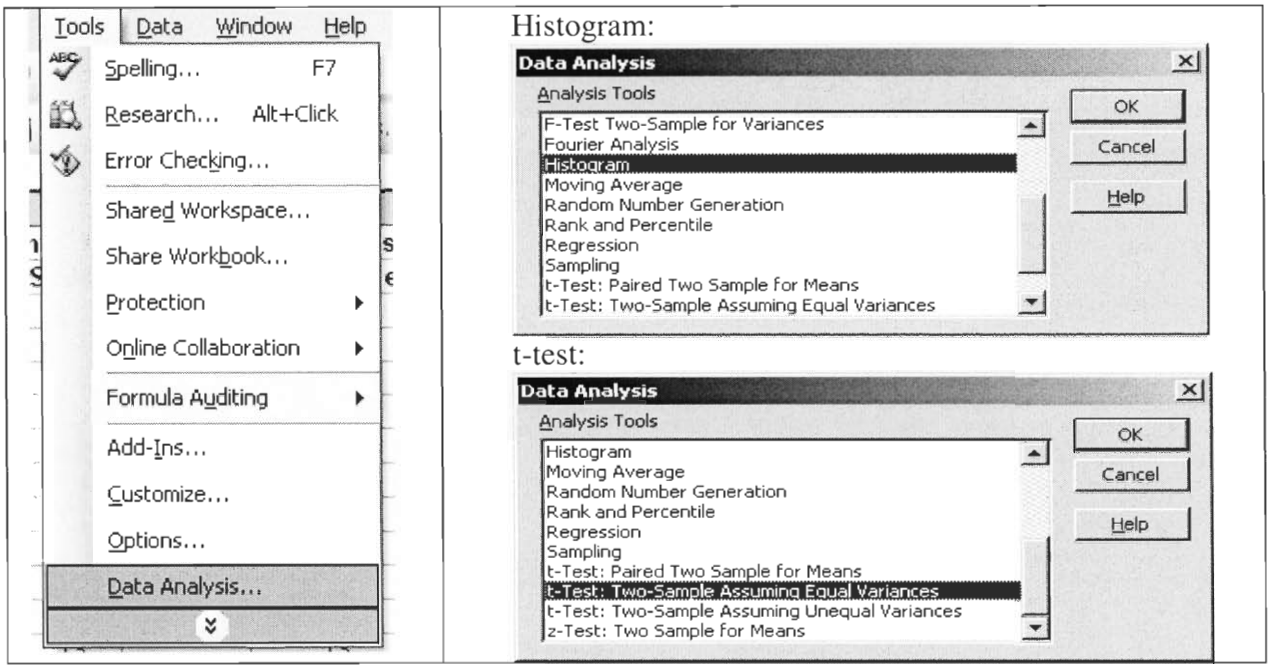


Figure 3.5 – Histogram: in Excel

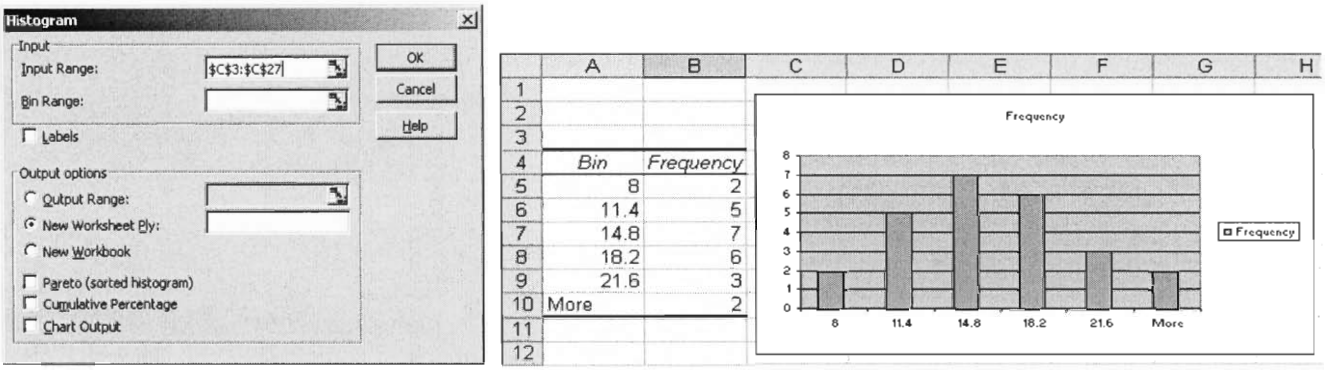
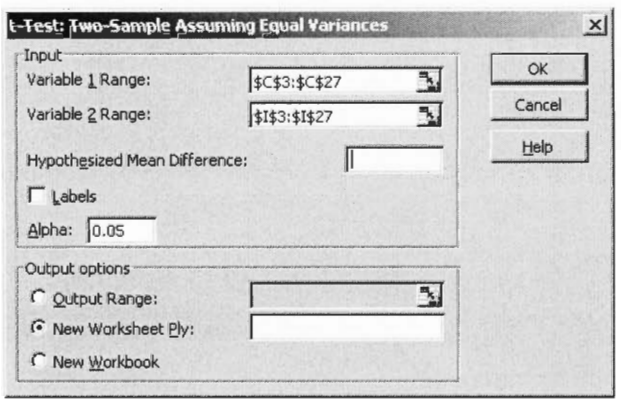


Figure 3.6 – t-test: in Excel

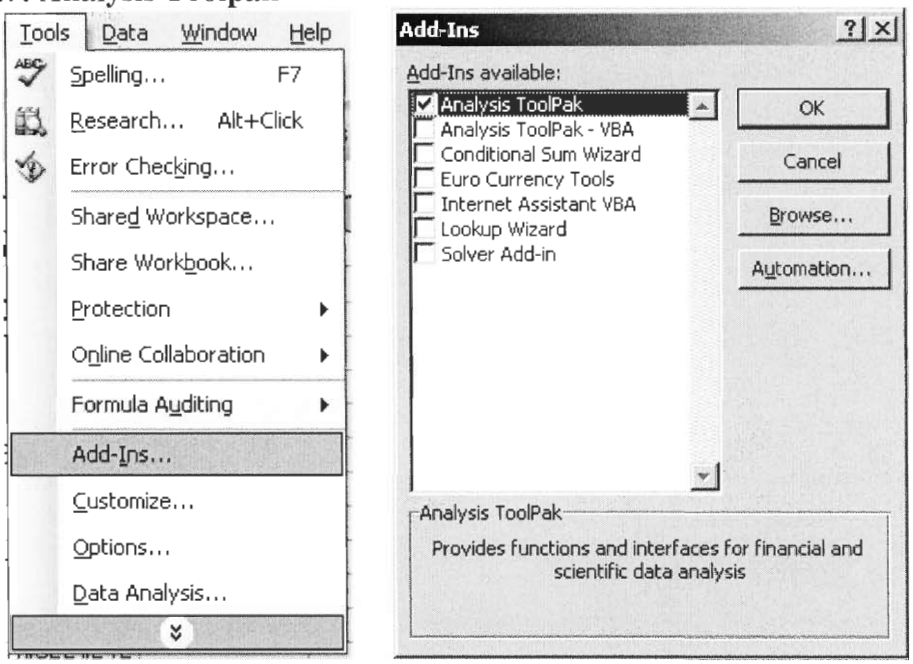


t-Test: Two-Sample Assuming Equal Variances

	Variable 1	Variable 2
Mean	14.36	17.28
Variance	20.99	31.04333333
Observations	25	25
Pooled Variance	26.01666667	
Hypothesized Mean Difference	0	
df	48	
t Stat	-2.0240071	
P(T<=t) one-tail	0.024277287	
t Critical one-tail	1.677224197	
P(T<=t) two-tail	0.048554575	
t Critical two-tail	2.010634722	

Note:
The Analysis ToolPak must be installed to do any of the Statistical Data Analysis in Microsoft Excel. To do so, select **Add-Ins** from the **Tools** drop down menu. Make sure that the **Analysis ToolPak** checkbox is checked and hit **OK.** (See Figure 3.7)

Figure 3.7: Analysis Toolpak



3.3 Cup Flipping Activity

Objective: To teach the students the importance of randomization in experiments and show what may happen in the absence of randomization.

Materials

- One plastic cup per student
- One coin per student
- A container filled with the names of all the students on slips of paper
- Paper

Procedure:

1. Each student's name will be drawn randomly from the container. The first half of student names drawn out of the hat will be put into group A. The remaining half will be put into group B.
2. Group A will first flip the cup with their non-dominant hand until it lands in drinking position. Then they will repeat with their dominant hand. The number of times it took to flip the cup with each hand will be recorded.
3. Group B will perform the experiment by first flipping a coin to decide whether they will flip the cup with their non-dominant hand or dominant hand first. Heads will correspond to dominant hand and tails to non-dominant hand.
4. Group B will perform the experiment with each hand in the order dictated by the coin and record the number of times it took them to land the cup with each hand and the order of which hand the used first.
5. Group A will repeat the experiment using step 4 and record their data.

Note to teacher:

Randomizing the order of the treatments as well as which treatments each student receives will eliminate confounding. Group A should show a better performance throughout with their dominant hand (lower number of flips with their dominant hand). By randomizing which hand is used first in group B, the ability of the student to learn and gain confidence with their dominant hand will be eliminated. The results of group B should yield a more equal number of flips between hands. Group A will perform the experiment again for the sake of replication.

4. Case Studies

4.1 Introduction

Throughout the entire process a case study was recorded for each student so that their progress could be monitored. At first, all of the students had case studies but after they submitted their initial project description, the projects were divided into those that could benefit from statistical help and those who couldn't. These case studies that wouldn't benefit were then closed. The remaining case studies continued to be updated.

Every case study contains the initial project description and project title. That is, however, where most of the case studies end. The students that were selected to be mentored have the results of a survey (See Appendix B) that was handed out, recommendations given to and questions asked of the student by their mentor, and any updates that the student made to the project.

The selection process was fairly simple for some cases and somewhat difficult for others. After seeing the initial project descriptions, a line was drawn between those students that had a clearly engineering-based project and those that were either purely experimental or that might have a testing stage that would benefit from some statistical analysis. After the survey results were reviewed for the students whose projects were not clearly engineering-based, the remaining projects were either selected for mentoring or were discarded. In order to decide to mentor a student, it had to be determined that they were going to have resulting data that could benefit from statistical analysis. A couple of the students had projects that required more statistical analysis than the mentors had experience with, these had to be referred to other sources and professors for aid and were not selected.

4.2 Mentored Students

4.2.1 Catharine

Initial Project Description: 10/30/03

Title: Antacid formulation

Description: I am trying to make a solution of antacid and some acidic juice to get an exact pH that serves as the pH before heartburn arises and folic acid/vitamin B12 can be absorbed. I think I will be getting data that will show me the vitamins being passed through.

Survey

1. *What is the Goal of your Project?*
To find a way for folic acid and vitamin B12 to be absorbed while using antacids for relief of heartburn.

2. *What result(s) do you expect?*
I expect that the vitamins will be absorbed through the membrane (if I use membrane filtration).

3. *How will you determine if your project has been successful?*
If the results I expect to occur than it will be successful.

4. *Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?*
I am trying to measure the amount of vitamins that passed through the membrane.

5. *How do you plant to measure this quantity or concept?*
The details on how the vitamins are measured are unsure to me. I have to research membrane filtration.

6. *Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.*
pH of solution of vitamins and acidic juice

Selection Process

This student was selected for mentoring because a clear set of data would be produced as long as a good experimental design was used. This project is experimental in nature and should produce results needing statistical analysis.

Mentor: Jon

Mentors Questions/Comments

- What are acceptable values?
- How many trials?
- Any variations?
- Measuring time of effectiveness/absorption?

Update: 2/5/04

- found ph values of several juices
- focusing on how much juice would need to be added to a solution of HCl (simulated stomach acid) in order to make a pH-4
- used test strips to determine ph values
- used 3 juices so far
- trying to figure out what juice would make pH-4 faster in stomach (which would be best to ingest and how much of it. The juice with the least volume would be better??)
- pH-4 is the best value for absorption of vitamin B12 – which would reduce the effects of heartburn.

Comments:

- Recommend trying to use more juices – more trials

Update: 2/12/04

This data does not seem to require statistical analysis; it mainly seems to be shaping into a chart that can be used for reference. She has data that pretty much suggests that the liquid with the highest pH will take the lowest amount of volume to make the stomach acid solution pH-4.

Science Fair: 2/19/04

Project title: The Effect of Antacids on Folic Acid and Vitamin B12

Result: Qualified for the Regional fair

4.2.2 Cece

Initial project description 10/30/03

Title: Plant Retardation in pavement cracks

Description: Plant growth in dirt, in Styrofoam, in soil. Depth of cracks, pavement composition, weed killer composition, effects of weed killer on various plants.

Survey

1. What is the Goal of your Project?
To make a mixture that can prevent germination of unwanted plants. The mixture would solidify and act as filler between sidewalk pavements.

2. What result(s) do you expect?
A somewhat successful mixture that retains herbicide properties

3. How will you determine if your project has been successful?
Test it against different types of weeds

4. Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?
Amount of effectiveness when herbicides are mixed with other materials like sand and concrete.

5. How do you plant to measure this quantity or concept?
Study herbicide composition as well as concrete composition

6. Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.
Types of chemicals in herbicides water solubility of herbicides and solid mix.

Selection process

This student was chosen because the experiment would be mainly examining the data that would be collected once the correct mixture is developed. It must then be tested to ensure that the mixture that she created is better than the original mixture. She will be comparing two against each other.

Mentor: Dave

Update: 2/05/04

CeCe has performed some of her tests but needs to do more. She has performed the test by using cracks in Styrofoam to simulate cracks in sidewalks.

Update: 2/12/04

CeCe has still not finished all of her data collection. She will show that the difference between the two mixtures that she used. She will be determining if the mixture that she developed is significantly different than the original mixture. She will be using a t-test in order to show that it is significant.

Science Fair: 2/19/04

Project title: Wasting Weeds in Sidewalk pavement.

Result: Qualified for the Regional fair

4.2.3 David

Initial Project Description: 10/30/03

Title: Improving Freezing tolerance of plants with AFP

Description: I will be collecting data about the temperature at which plant cells die. I will change the amount of AFP for different samples.

Survey

1. *What is the Goal of your Project?*

The goal of my project is to see if using AFP with plant cells will increase the freezing tolerance enough to help agriculture in frost-prone regions.

2. *What result(s) do you expect?*

I expect an increase in freezing tolerance but don't know to what degree.

3. *How will you determine if your project has been successful?*

I still have to research what amount of freezing tolerance will be useful but through initial research if it was by 2 or 3 degrees Celsius if will be successful.

4. *Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?*

Measure the temperature at which plant cells die.

5. *How do you plan to measure this quantity or concept?*

I will use a microscope with gradually lowering temperature.

6. *Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.*

- Concentration of AFP in a glycerol solution
- Type of plant cells
- Different parts of citrus plants
- Length of time immersed in AFP solution before cooling

Selection Process

This student was chosen for selection because has a clear hypothesis and will be testing a response variable that will yield good hard data.

Mentor: Geoff

Mentor Questions/Comments:

1. How will you accurately measure Death?
2. How many different concentrations of AFP will be used?
3. Will a clean sample be used between increasing concentrations of AFP
4. How many types of plant cells?
5. How many different levels of time exposure to AFP will there be?
6. How much replication will be used for each treatment?

Update: 2/5/04

David has not yet begun to collect data but will begin soon. He wishes to use three or four different concentrations of AFP and will only be performing his experiment on one type of plant cell. He is unsure how much replication he will be able to get because of time constraints.

Update: 2/12/04

David has not yet collected any data but will start soon. David decided to only one use one type of AFP at four different concentrations.

Mentor Recommendation:

It was recommended that David perform a T-test or an F-test to analyze his data once collected so that he can draw conclusions based on the comparisons between the four different concentrations of AFP.

Science Fair: 2/19/04

Project Title: The Effects of Antifreeze Proteins on the Depression of the Freezing Point of Citrus Plant Cells.

Result: Did not qualify for the Regional fair.

4.2.4 Elizabeth

Initial Project Description: 10/30/03

Title: Coral bleaching

Description: I'm going to impose the effects of the zooxanthallae on a coral w/ a low mortality rate on the zooxanthallae w/a high mortality rate. I will need two species of live coral. I will be measuring how well they survive during a coral bleaching event.

Survey Section:

1. *What is the Goal of your Project?*
Goal is to decrease the fatal effects of coral bleaching on a species of coral with a high mortality rate due to it by giving it the zooxanthallae of a species of coral with a low mortality rate.

2. *What result(s) do you expect?*
Hope that the 'better' zooxanthallae will help the coral survive better after it undergoes coral bleaching.

3. *How will you determine if your project has been successful?*
If the coral survives, the project will be successful.

4. *Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?*
I'm trying to measure survival rate, but during the process I need to measure how well the coral accepts the foreign zooxanthallae.

5. *How do you plant to measure this quantity or concept?*
The survival rate is basically a yes or no type of thing. To measure how well the zooxanthallae is accepted could be done on a color scale that I would set. Not sure though.

6. *Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.*
Water temp, salinity, subjective view

Selection Process:

This student was selected for mentoring because a clear set of data would be produced as long as a good experimental design was used. This is project is experimental in nature and should produce results needing statistical analysis, as long as the outside variables can be controlled.

Mentor: Jon

Mentors Questions/Comments

Define survival rate? What is acceptable?
Where is the coral coming from and can this be replicated?

Update: 2/5/04

- Coral died during shipment. Expecting new shipment soon.
- Has 3 populations to be put into 3 different tanks.

- Testing coral's mortality against amount of movement intake
- Will be simulating waves
- Expects that the tank with the least amount of waves to die faster.
- Will be taking digital pictures from each tank
  - Will take RGB values from many spots a few times a day for the span (perhaps until dead)

Update: 2/12/04

Coral had arrived and she is going to be testing throughout the weekend. Still no results.

Update: 2/16/04

Samples were taken every 2 hours for about 30 hours. These samples consisted of digital pictures of the coral samples in each tank. The coral was split up into 3 groups:
1. Aruba which was 84 gal/min at 74°. 2 samples were taken every 2 hours.
2. Bahamas was 200 gal/min at 85°. 3 samples were taken every 2 hours.
3. Cancun was 0 gal/min at 85°. 3 samples were taken every 2 hours.

Met her with Professor Wilbur to go over data and come up with a way to analyze it. Analysis was done with SAS and it was to show significance between the different populations of coral. Multiple regression was the approach used to display the data.
(Data presented in Tables 4.1 and 4.2, SAS code in Table 4.3)

Update: 2/18/04

Student collected additional data at 40, 50, and 60 hours. She met with Professor Wilbur to make sure that she performed the correct analysis.

Science Fair: 2/19/04

Project title: The Effects of the Intensity of Water Movement on the Rate of Coral Bleaching.

Result: Qualified for the Regional fair

Table 4.1 – Data for coral bleaching study: hours 0-18

		Aruba			Bahamas				Cancun			
Hours	Colors	1	2	Temp.(F)	1	2	3	Temp.(F)	1	2	3	Temp. (F)
0	red	103	80	76	107	79	75	76	123	117	118	76
	green	102	118		102	76	74		112	103	107	
	blue	60	68		59	43	51		93	63	89	
2	red	104	85	76	143	121	122	85	135	121	100	80
	green	100	100		137	102	123		125	108	87	
	blue	60	59		100	72	88		93	70	54	
4	red	111	86	76	141	120	121	84	119	114	105	82
	green	114	112		144	111	121		111	96	95	
	blue	66	51		112	78	82		86	64	68	
6	red	117	84	75	127	114	125	82	116	110	100	85
	green	118	114		112	102	133		95	91	83	
	blue	67	58		77	65	103		73	56	65	
8	red	116	86	76	138	125	127	84	140	122	121	86
	green	112	110		142	117	129		124	107	103	
	blue	70	67		111	86	102		93	79	89	
10	red	124	100	76	138	124	125	86	124	141	106	86
	green	118	117		139	112	128		111	123	97	
	blue	60	66		107	84	99		81	81	71	
12	red	117	87	76	167	136	121	86	150	153	115	85
	green	109	90		164	128	102		135	125	99	
	blue	68	53		134	106	72		113	99	80	
14	red	104	104	76	155	131	141	88	134	154	113	86
	green	101	106		152	120	135		107	130	95	
	blue	79	63		120	94	97		86	112	80	
16	red	119	108	79	158	125	123	88	140	145	108	86
	green	116	121		149	111	107		117	120	77	
	blue	80	76		111	76	83		84	94	64	
18	red	141	113	78	153	125	113	88	126	147	117	86
	green	143	127		146	101	92		110	122	93	
	blue	90	73		112	74	69		79	99	78	

Table 4.2 – Data for coral bleaching study: hours 20-60

		Aruba			Bahamas				Cancun			
Hours	Colors	1	2	Temp.(F)	1	2	3	Temp.(F)	1	2	3	Temp. (F)
20	red	137	97	77	142	121	117	87	125	166	100	87
	green	133	126		128	107	107		102	147	67	
	blue	80	69		103	76	99		75	128	55	
22	red	144	118	75	150	120	136	85	161	168	168	86
	green	146	134		135	105	121		152	146	153	
	blue	106	84		106	69	102		141	141	145	
24	red	121	116	76	146	122	137	84	133	168	121	85
	green	109	125		148	108	118		112	150	93	
	blue	69	72		128	78	82		94	151	91	
26	red	135	132	77	149	106	94	84	156	173	126	86
	green	135	145		148	94	81		136	152	106	
	blue	105	108		130	77	60		117	151	102	
28	red	132	117	75	150	125	112	84	137	170	135	85
	green	125	148		138	104	96		111	147	110	
	blue	79	100		100	64	62		88	133	103	
30	red	135	120	75	149	123	106	84	174	174	136	86
	green	136	146		131	104	95		150	152	105	
	blue	83	89		93	64	70		127	137	97	
40	red	133	107	75	151	127	133	88	158	180	122	86
	green	130	123		133	109	128		126	160	91	
	blue	79	74		109	80	105		109	151	77	
50	red	127	105	75	154	136	129	88	169	226	127	86
	green	127	116		135	113	103		148	228	94	
	blue	79	80		119	86	78		141	234	70	
60	red	128	99	77	182	165	147	86	219	236	131	86
	green	123	112		164	152	136		220	239	100	
	blue	78	65		154	138	114		229	240	83	

Table 4.3 – SAS code used

```
data temp;
      input hours group $ lum tempf;
      cards;
0     A     97.68       76
2     A     96.8        76
4     A     107.82      76
6     A     112.09      75
8     A     108.58      76
10    A     113.42      76
12    A     106.89      76
14    A     99.48 76
16    A     112.94      79
18    A     136.57      78
20    A     128.37      77
22    A     141         75
24    A     108.2       76
26    A     131.7       77
28    A     122.04      75
30    A     129.87      75
0     A     101.1       76
2     A     90.99       76
4     A     97.49       76
6     A     98.84       75
8     A     98.07       76
10    A     106.29      76
12    A     85.03       76
14    A     100.67      76
16    A     112.15      79
18    A     116.86      78
20    A     111.03      77
22    A     123.7       75
24    A     116.47      76
26    A     137.03      77
28    A     133.42      75
30    A     131.93      75
0     B     98.77       76
2     B     134.73      85
4     B     139.58      84
6     B     112.65      82
8     B     137.39      84
10    B     135.18      86
12    B     161.6       86
14    B     149.38      88
16    B     147.52      88
18    B     144.36      88
20    B     129.45      87
22    B     136.31      85
24    B     145.2       84
26    B     146.32      84
28    B     137.42      84
30    B     132.22      84
0     B     73.27       76
2     B     104.4       85
4     B     110.07      84
6     B     101.53      82
8     B     115.99      84
10    B     112.52      86
12    B     127.98      86
```

14	B	120.44	88
16	B	111.35	88
18	B	105.23	88
20	B	107.79	87
22	B	105.54	85
24	B	108.9	84
26	B	95.73	84
28	B	105.9	84
30	B	105.3	84
0	B	71.77	76
2	B	118.85	85
4	B	116.71	84
6	B	127.3	82
8	B	125.43	84
10	B	123.91	86
12	B	104.4	86
14	B	132.62	88
16	B	109.16	88
18	B	95.77	88
20	B	109.12	87
22	B	123.41	85
24	B	119.74	84
26	B	82.59	84
28	B	97.06	84
30	B	95.55	84
0	C	113.21	76
2	C	124.48	80
4	C	110.65	82
6	C	98.88	85
8	C	125.39	86
10	C	111.6	86
12	C	137.08	85
14	C	112.79	86
16	C	120.27	86
18	C	111.39	86
20	C	105.93	87
22	C	153.49	86
24	C	116.32	85
26	C	139.91	86
28	C	116.27	85
30	C	154.67	86
0	C	102.8	76
2	C	107.72	80
4	C	97.88	82
6	C	92.85	85
8	C	108.42	86
10	C	123.78	86
12	C	130.54	85
14	C	135.22	86
16	C	124.64	86
18	C	126.97	86
20	C	150.61	87
22	C	152.05	86
24	C	155.51	85
26	C	158.19	86
28	C	152.36	85
30	C	156.95	86
0	C	108.32	76
2	C	87.27	80
4	C	95.03	82

```
6     C     86.12       85
8     C     106.86      86
10    C     96.84       86
12    C     101.71      85
14    C     98.75       86
16    C     84.87       86
18    C     98.55       86
20    C     75.58       87
22    C     156.62      86
24    C     101.18      85
26    C     111.56      86
28    C     116.73      85
30    C     113.42      86
40    A     125.290     75
40    A     112.810     75
50    A     121.720     75
50    A     108.740     75
60    A     119.550     77
60    A     102.930     77
40    B     135.760     88
40    B     111.210     88
40    B     126.970     88
50    B     138.940     88
50    B     116.930     88
50    B     108.050     88
60    B     168.300     86
60    B     154.360     86
60    B     136.880     86
40    C     133.730     86
40    C     165.010     86
40    C     98.760      86
50    C     153.530     86
50    C     228.060     86
50    C     101.260     86
60    C     220.690     86
60    C     238.210     86
60    C     107.430     86
;
run;

data temp;
      set temp;
      x1 = (group eq "A") ;
      x2 = (group eq "B");
      x3 = (group eq "C") ;
      hours1=x1*hours;
      hours2=x2*hours;
      hours3=x3*hours;
run;

proc reg data=temp;
      model lum=x1 x2 x3 hours1 hours2 hours3 tempf  /noint;
      test hours1=hours3; * does a hypothesis test for equality of
slopes for group B and group C;
run;

proc reg data=temp;
      model lum=tempf /r; * the "r" computes residuals; * this fits a
simple linear regression of lum on temp;
```

```
      output out=temp r=lumadj; * outputs residuals into dataset temp
in a variable called "lumadj";
run;


proc sort data=temp;
      by group hours;
run;

symbol1 c=blue v=none i=rl; * v=none will get rid of the dots, v=circle
circles,...";
symbol2 c=green v=none i=rl; * i=rl gives a regression line, i=none,
i=sm70,..;
symbol3 c=ed v=none  i=rl; * c is color;

proc gplot data=temp;
      plot lumadj*hours=group;
run;
```

End Table 4.3

4.2.5 Garret

Initial project description 10/30/03

Title: Analysis of the vibration dampening of skis

Description: I will be measuring the dampening coefficients of different types of skis of various materials in skis. I will use a strain gauge and an oscilloscope.

Survey

1. What is the Goal of your Project?
My goal is to find out which materials used in ski damp vibrations more than others

2. What result(s) do you expect?
Materials used in race skis dampen vibrations more than materials used in beginner skis

3. How will you determine if your project has been successful?
My project will be successful to tell which materials should be used

4. Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?
n/a

5. How do you plant to measure this quantity or concept?
I plan to put strain gages on skis and materials and record results on an oscilloscope from the graph given from the oscilloscope. I will measure the damping. My experiment setup is based on a twang test.

6. Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.

a. Length of ski/material
b. Mass of ski/material
c. Position of strain gages on skis and materials
d. Shape of materials

Selection Process

This student was chosen because his experiment would be mainly testing the skis and determining if the different strengths are significantly different. The project will involve a t-test to distinguish the difference.

Mentor: Dave

Mentor Questions/Comments

1. Will you measure the skis at the same point?
2. How will you choose this point if the skis have different dimensions?
3. Will the same manufacturer make all of the skis?

Update: 2/5/04

Garrett has done all of his tests and is looking for a way to analyze the results.

Update: 2/12/04

Garrett is given instructions on how to perform a t-test to determine if there is a difference between the two skis. He seems very excited about it and I am sure that he will utilize it.

Science Fair: 2/19/04

Project title: Ski Dampening.

Result: Qualified as alternate for the Regional fair

4.2.6 Jessica

Initial Project Description: 10/30/03

Title: The Development of an antifungal mat treatment for use in public gyms, locker room, and shower rooms.

Description: I'm going to first test the potency of various antifungal agents on fungi that cause ringworm and athletes foot, and will be developing a mat or mat treatment which will kill fungus. I will be measuring the cost, durability, potency and effectiveness.

Survey

1. *What is the Goal of your Project?*

The goal of my project is to develop an antifungal mat treatment which would release an antifungal agent to kill fungi such as T. Flacasum which causes athletes foot. I will be testing the resistance to certain fungicides and determine the best agent to use.

2. *What result(s) do you expect?*

I expect to determine the most efficient safe and long-lasting antifungal agent, and then implement it into a floor drying system.

3. *How will you determine if your project has been successful?*

I will determine if my project is successful if I can develop an agent that will kill and prevent the growth of fungi on mats in public gyms, locker rooms, showers, mats.

4. *Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?*

I will be measuring the resistance of the fungi to the fungicide, how much fungi remains after the treatment, and how long the fungicide is effective before reimplementation.

5. *How do you plan to measure this quantity or concept?*

Counting fungi through a microscope and measure time.

6. Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.

- Concentration of fungicide
- Fungicide type
- Health of fungi colony

- Temperature
- Starting amount of fungi

Selection Process

This student was selected because at the least the student will have some quantifiable data on the effectiveness of the agent to kill the bacteria, which we can work with easily and show statistical knowledge. Initially there were worries that this student would be stuck in the development phase for the duration of the project but it turns out the student is not developing the mat but solely the killing agent. Good hard data will be produced.

Mentor: Geoff

Mentor Questions/Comments

1. How much time will the development of this project take?
2. Are you going to vary the amounts of killing agent?
3. How will you introduce the agent to the fungus?
4. Will you always start with a clean sample?
5. What percent of fungus death will yield successful and meaningful results?
6. How long does the fungicide have to be effective to be considered effective?
7. Will this be tested on an already created mat?

Update: 2/5/04

In her initial data collection her fungi were all killed. She will be collecting data again soon. Her project has changed some at this point. She is going to be testing seven different herbal extracts and measuring the growth of fungus toward an antifungal disc in her sample. She plans to test 5 samples of each herbal extract and her data will be a measure of distance fungi has grown toward the antifungal disc.

Update: 2/12/04

Jessica is continuing to collect data at this point will have at least 40 samples when completed

Mentor Recommendation:

It was recommended that Jessica perform an F-test because she will be comparing multiple groups.

Science Fair: 2/19/04

Project Title: The Effectiveness of Herbal Antifungal Treatments on the Dermatophyte Epidermophyton Floccosoum

Result: Did not qualify for the Regional fair.

4.2.7 Jocelyn

Initial project description 10/30/03

Title: Plant Color

Description: I am going to grow white flowers using hydroponics. I am going to try different techniques to see if rooted plants absorb color the same as those without roots. When I figure out the best way, I will try to change the colors of vegetables.

Survey

1. What is the Goal of your Project?
I want to determine if plants with roots absorb color the same as plants without roots and use this to possibly change the color of vegetables

2. What result(s) do you expect?
I expect them to absorb the color

3. How will you determine if your project has been successful?
If the vegetables change, it is successful

4. Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?
I will measure the extremity of the color

5. How do you plant to measure this quantity or concept?
I will compare and contrast

6. Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.
- Amount of color vs. water
- Type of flower
- Color of flower
- Dye color

Selection process

This student was chosen because the experiment would involve measuring the change in color if there was a change. The experiment would involve doing several tests to see if the color of the plant has changed from its original color. .

Mentor: Dave

Mentor Questions/Comments

1. How will you quantify the change in color?
2. Will you be using the same type of plant?
3. How much dye will be absorbed by the soil and is there a way to eliminate the amount of dye absorbed by the soil.
4. Will the plants be developed at the same stage?

Update: 2/5/04

Jocelyn has not started anything. I made sure that she had her experimental design correct.

Update: 2/12/04

Jocelyn still has not done anything so I gave her information on how to perform a t-test for the two types of flowers. I told her to take as many pictures as possible from the same angle with the same lighting scheme.

Science Fair: 2/19/04

Project title: Absorbency of Food Coloring in Plants with Roots.

Result: Did not qualify for the Regional fair

4.2.8 Jonida

Initial project description 10/30/03

Title: The Effects of Caffeine on ants

Description: I am going to have two ant farms. I will feed caffeine to one of them and see how their behavior will differ. I will collect data of their walking speed, their ability to kill intruders, and the rate at which they carry seeds into their nests.

Survey

1. What is the Goal of your Project?
The goal is to see whether caffeine will affect movement and aggressive behavior

2. What result(s) do you expect?
I expect to find that the ants which will be fed caffeine will have a more movement and aggressive behavior

3. How will you determine if your project has been successful?
I will determine this if I find that the ants will react the way I expect them to.

4. Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?
Movement and aggressive behavior

5. How do you plant to measure this quantity or concept?
I plan to measure movement by comparing the length of time it takes separate ant farms to transfer seeds into their tunnels. I also plan to see how long it takes for the ants to get from one point to another. To measure aggressive behavior I have to put an intruder in the ant farms and see which ants kill the intruder quicker.

6. Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.
The factors that might influence the change in the ant behavior might be the dosage of caffeine used.

Selection process

This student was selected for mentoring because it was obvious that she would need help with quantifying her data and once she had done that it would be a statistically based project. She would be comparing the two ant colonies to see if there was a difference in speed and aggressive behavior.

Mentor: Dave

Mentor Questions/Comments 10/30/03

1. How will you make sure that the entire colony will get the same amount of caffeine?
2. Is there any other method to measure how fast they walked?
3. Is the colony going to be used for both runs of the experiment (caffeine and non-caffeine)?
4. How are you going to give the control group a placebo that resembles caffeine without any of the effects of caffeine?

Update: 2/5/04

Jonida had performed her experiment and after her first couple runs through the experiment she had killed all of the ants. She says that the ants that were given the caffeine seemed to move faster than the ones that did not.

Update: 2/12/04

Jonida has done nothing since that last meeting. I showed her how to perform a t-test in Microsoft Excel. She thought that the t-test would be perfectly fit for her project.

Science Fair: 2/19/04

Project title: The Behavioral Effects of Caffeine on Carpenter Ants

Result: Did not qualify for the Regional fair

4.2.9 Lizbeth

Initial Project Description: 10/30/03

Title: Factors which affect a shopper's attraction to a display
Description: I will be displaying a certain product differently on separate occasions and counting both the number of people who come in and out of the store, and the number of people that touch the product. The goal is to see what factors can be changed to increase the customers attraction.

Survey

1. *What is the Goal of your Project?*
To find new factors to manipulate associated with display units that will affect the attraction of customers to the display.

2. *What result(s) do you expect?*
I expect the lesser number of items on a display and more people in the store wearing the item to increase the people's attraction to the display. However, I expect the more people looking at a display to decrease the attraction.

3. How will you determine if your project has been successful?
If I increase people's attraction to a display by manipulating it.

4. Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?
People's attraction to an item on display.

5. *How do you plant to measure this quantity or concept?*
I plan to set up a scale with different measures of attraction.

6. Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.
Day, Time of day, discrepancies as to whether someone actually looked at the item or not, how to set up scale.

Selection Process

This student was selected for mentoring because it was felt that he could be helped in trying to develop the experiment so that there would be good data to compile. As the project description stands, it is unsure how much help this student will be able to receive unless there will be some kind of data that can be analyzed.

Mentor: Jon

Mentors Questions/Comments:

How to measure attraction?

How many trials??(full display with people wearing it, full without, and empty with and without)

Update: 2/5/04

Table 4.4 – Results from display manipulation

Items on shelf	People walking in store	People walking by – not touching	People walking by – touching	Bought item	Percentage of people touching
9	195	64	4	1	5.88
4	139	41	3		6.89
14	131	37	2		5.1
9 (while wearing item)	188	57	3		5

Item – a long sleeve cotton shirt – assumed that it was not a popular selling item to begin with

Comments:

- What to do with this data?
- Told her to try and get more trials, use a different product if she has to
- Told her to try and get the sales info (if any) from the store on that item

Update: 2/12/04

More data was collected. Cochran-Armitage trend test was recommended as the best method of analysis. The test showed that the data was statistically insignificant. This was most likely because not enough data was taken to show anything significant.

Science Fair: 2/19/04

Project title: On Display: Considerations in Retail Product Presentation.

Result: Did not qualify for the Regional fair

4.2.10 Maggie

Initial Project Description: 10/30/03

Title: Effect of Varying non-Earth atmospheric Pressures and Compositions on the survival and oxygen Production of Cyanobacteria.

Description: I will be measuring the percent of living vs. the percent of dead bacteria and the amount of oxygen produced. There will be twenty jars to measure.

Survey

1. What is the goal of your project?

The goal of this project is to establish the combination of atmospheric pressure and the composition that is conducive to growth of cyanobacteria.

2. What result(s) do you expect?

I expect that the bacteria will prefer lower percentages of Nitrogen and higher atmospheric pressures.

3. How will you determine if your project has been successful?

If there is a noticeable difference in the oxygen production of bacteria in various conditions, it will be successful.

4. Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?

The main quantity that will be measured is oxygen levels.

5. How do you plan to measure this quantity or concept?

I will measure the oxygen levels with oxygen sensors or barometers.

6. Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.

- Number of bacteria
- Pressure
- Amount of light
- Temperature
- Human error
- Water

Selection Process

This project was chosen because this student has a clear hypothesis and can easily measure the response variables to test her hypothesis and get hard data.

Mentor: Geoff

Mentor Questions/Comments:

1. What percent of oxygen production will be considered successful?
2. How many samples will be tested?
3. What is the benefit to cyanobacteria for producing more oxygen?
4. What do you base your expectations on?
5. How will you assign your treatments?
6. Make sure to separate atmospheric pressure and Nitrogen levels separately to eliminate confounding.

Update: 2/ 5/04

Maggie has since changed her project but provided me with a copy of her abstract which is given below. She is going to try to duplicate the project once more to get more data.

Abstract: The effect of three rapid rates of increase and decrease in temperature on the amount of dissolved oxygen produced by the cyanobacterium *Oscillatoria* was examined to model conditions that they might have to survive in introduced to the Martian environment in the process of terraformation. It was hypothesized that greater rates of change would result in less oxygen produced because there would be an increased stress in the bacteria's environment and they would waste energy on adapting to the change instead of using it to photosynthesize. The bacteria were cultured in individual test tubes and kept in an environment of moderate lighting and temperatures of about 65°F. There were then randomly divided into groups and placed in water baths that changed the temperature of their environment by 15°C or -15°C in amounts of time averaging 4.125, 6.9, and 12 minutes. A final dissolved oxygen reading was taken and compared to the dissolved oxygen of the solution before bacteria were introduced to it. It was found that the hypothesis was supported and the bacteria that had undergone more rapid rates of temperature change produced less oxygen on average. It may thus be concluded that subjecting *Oscillatoria* to very rapid rates of temperature change would significantly reduce their oxygen producing capabilities and could potentially affect their influence on the Martian environment.

Update: 2/12/04

Maggie wants to continue to collect data at this point and get as much replication as possible.

Mentor Recommendation:

It was recommended that Maggie explore the relationship between dissolved oxygen and rate of temperature change through a graph and try to estimate a function.

Science Fair: 2/19/04

Project Title: Rapid Temperature Change on Oxygen Production of Oscillatoria for Martina Terraformation

Result: Qualified for the Regional fair.

4.2.11 Pat

Initial Project Description: 10/30/03

Title: Effects of rust on metals

Description: I intend to use different kinds of metal and test their strengths before and after they have corroded. I will be testing strengths such as tensile and compression.

Survey

1. *What is the Goal of your Project?*
Goal is to create a model of the relationship between the strength of a metal and the amount of corrosion it endures.

2. *What result(s) do you expect?*
I expect that there will be a decreasing relationship between the strength of a metal and the increasing amount of corrosion.

3. *How will you determine if your project has been successful?*
It will be successful if I can create a model to show the relationship between corrosion and strength.

4. *Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?*
Trying to measure Tensile, Compression, and Shear strength.

5. *How do you plant to measure this quantity or concept?*
Several machines specifically designed to test these strengths.

6. *Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.*
Amount of corrosive material, mass, density, and kind of metal.

Selection Process

This student was selected for mentoring because it was felt that he could be helped in trying to develop the experiment so that there would be good data to compile. As the project description stands, it is unsure how much help this student will be able to receive unless there will be some kind of data that can be analyzed. It seems that the end results may be such that can be put into a reference table.

Mentor: Jon

Mentors Questions/Comments:

How to measure corrosion and how to control amount?
Size/shape of pieces?

Update: 2/5/04

Not present, perhaps no data yet. Will check on 2/12

Update: 2/12/04

Data had been taken. He took rods of the metal and used a lathe to make them hourglass shaped. He used strength tests that involved pulling the metal apart from both ends. This data does not seem to require statistical analysis; it mainly seems to be shaping into a chart that can be used for reference.

Science Fair: 2/19/04

Project title: How corrosion affects the delayed failure due to hydrogen embrittlement.

Result: Qualified for the Regional fair

4.2.12 Sang

Initial Project Description: 10/30/03

Title: Stimulation of Phytoplankton Growth

Description: In my project I will increase the amount of CO_2 intake of phytoplankton by stimulating the phytoplankton with iron fertilization. In this project I will try to find the ration between the iron and the fixed amount of CO_2 by phytoplankton.

Survey

1. *What is the Goal of your Project?*

To increase the amount of CO2 intake of phytoplankton by increasing the amount of certain metals such as phosphorous, iron, and nitrogen.

2. *What result(s) do you expect?*

I expect the phytoplankton would increase its intake of CO_2

3. *How will you determine if your project has been successful?*

I will determine if my project has been successful, according to my data from the CO_2 measurement device.

4. *Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?*

I am trying to measure the quantity of CO_2 in a closed atmosphere, and the amount of phytoplankton in the water.

5. *How do you plan to measure this quantity or concept?*

I will measure this quantity with a CO_2 measurement device, and mathematics.

6. *Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.*

- Amount of UV rays
- Amount of gases
- Amount of phytoplankton
- Amount of water
- Amount of nutrients in water
- Temperature
- Time

Selection Process

This student was selected for mentoring because good hard data would be produced from a clear response variable as long as a good experimental design was used. This is project is experimental and has no issues with development.

Mentor: Geoff

Mentors Questions/Comments:

1. What level of increased CO2 intake would be considered considerable or successful?
2. How many samples will receive each treatment?
3. Will one sample receive more than one treatment?
4. How will you isolate which treatments are linked to success?
5. Will there be a control group used?
6. How much replication will be used for each treatment?

Update: 2/5/04

Sang is now in the process of collecting data. His project has changed some. He will be adding trace metals through a process called F/2. There will be one constant concentration of trace metals in his experiment. He is using two types of phytoplankton and will have samples with and without trace metals present. He plans to have 5 replications for each group.

Update: 2/12/04

Sang is still in the process of collecting data at this point. He needs more time for the phytoplankton to grow.

Mentor Analysis recommendation:

After reviewing Sang project it was recommended to him to perform a T-test with the type of data he will be collecting.

Science Fair: 2/19/04

Project Title: Stimulating Phytoplankton to Reduce Atmospheric CO_2

Result: Did not qualify for Regional fair

4.2.13 Sidney

Initial project description 10/30/03

Title: How does wood affect the output of acoustic guitars?

Description: I am going to record the output of acoustic guitars of the same brand, but with different woods. I will keep the fret board in constant tune but will change the wood used to build the body and sides of the guitar. I will then analyze the properties of the waves, such fundamental frequencies and pitch.

Survey

1. What is the Goal of your Project?
I'm going to see what has a greater effect on the output of acoustic guitars, either the strings used or the wood for the body.

2. What result(s) do you expect?
I expect the strings to have a greater effect on the resonance as the to the woods

3. How will you determine if your project has been successful?
If I find a great variance between the test subject of resonance

4. Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?
I will measure frequency, intensity and pitch

5. How do you plant to measure this quantity or concept?
I plan to measure to measure with a microphone

6. Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.
Different plucking techniques and bridge types

Selection process

This student was chosen because the experiment would be mainly examining the data that would be collected. Since Sid would only be collecting data from two different guitars a t-test would be appropriate.

Mentor: Dave

Mentor Questions/Comments

1 How will you make sure that the same volume and correct note are hit for the different guitars?
2 Will the microphone be placed at the same distance from the port on the guitar?
3 Will the same strings be used for the different guitars?
4 Does the company make the same guitars in different types of wood?

Update: 2/5/04

Sid has done some testing and is going to go back and redo the tests again to make sure that the strings are the same on the guitars as well. He has narrowed down the types of guitars to two.

Update: 2/12/04

Sid had collected all of his data. I showed him how to perform a t-test in Microsoft Excel. He liked the idea of using Excel for determining that there was a difference between the two types and will be using it.

Science Fair: 2/19/04

Project title: Does the wood vibration in the Body of the Acoustic Guitar Affect it Output

Result: Did not qualify for the Regional fair

4.2.14 Tom

Initial Project Description: 10/30/03

Title: Subliminal Messages

Description: I will make 2 videos, one with a subliminal message and one without one. I well then present these tapes to different audiences. I will test if the subliminal message affected their desires.

Survey

1. *What is the Goal of your Project?*
To determine what, if any, effect subliminal messages embedded in video have on people's perception and persuasion.

2. *What result(s) do you expect?*
Expect to find out whether the message will affect the viewers opinions/desires.

3. *How will you determine if your project has been successful?*
I will use the data discovered and make generalizations. The project will be successful b/c I will either find the message did or didn't.

4. *Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?*
I plan to message unconscious perception of a product's ad.

5. *How do you plant to measure this quantity or concept?*
I will make 3 groups watch 3 different videos. One will have a really short message, a longer, and one with no message. I'll give them a questionnaire after and see if they would rather have the product advertised – therefore being subliminally aware of the message.

6. *Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.*
Conscious/unconscious perception, awake-ness during test, lighting, distance from TV, noise level, attentiveness, distractions in the room.

Selection Process

This student was selected for mentoring because it was felt that he could be helped in trying to develop the experiment so that there would be good data to compile. As the project description stands, it is unsure how much help this student will be able to receive unless there will be some kind of data that can be analyzed. If he can come up with a decent method of being able to conduct this experiment, there may be data to analyze.

Mentor: Jon

Mentors Questions/Comments

How will these factors be controlled?
Will the message and what's on the video be completely unrelated?

Update: 2/5/04

Tested 2 groups, one with a short message (1 frame) and one with a long (2 frames)
Asked them what they wanted to drink before and after
Message – 'Drink Water'

2nd group's data may have been skewed because a coke bottle was accidentally left on a table. Data will most likely be disregarded.

Will try to get more trials in, may have to change message due to people knowing what the message is now around the school.

Update: 2/12/04

More data was taken. Cochran-Armitage trend test was chosen as the best method of analysis. The test showed that the data was statistically insignificant; this was most likely because not enough data was taken to show anything significant.

Science Fair: 2/19/04

Project title: Subliminal Messages

Result: Did not qualify for the Regional fair

4.2.15 Vijay

Initial Project Description: 10/30/03

Title: Global Warming and Phytoplankton

Description: I am going to subject phytoplankton to high UV-B radiation levels and low salinity levels. I am trying to see if this will alter the photosynthetic sites.

Survey

1. What is the goal of your project?

Determine the correlation between photosynthetic production and global warming.

2. What result(s) do you expect?

I expect that more ultra violet radiation and lower [salt] negatively affect photosynthetic production.

3. How will you determine if your project has been successful?

If the results are constant, not varying, regardless if they are consistent with my expectations.

4. Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?

The primary quantities I am trying to measure in my project are Glucose production and color of chlorophyll

5. How do you plan to measure this quantity or concept?

Using RGB values.

6. Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.

(No response)

Selection Process

This student was chosen because the project is clear cut and not developmental. Statistics can easily be implemented into this project because a clearly drawn hypothesis is present and response variables can be clearly tested.

Mentor: Geoff

Mentor Questions/Comments

1. How much does photosynthetic production need to be affected to be considered significant?
2. How many different levels of UV and Salt will be tested?
3. How many Samples will be tested?
4. How much replication will there be per treatment?
5. Will the variables be separated to see which ones contribute to the most difference?
6. Will there be a control group.

Update: 2/05/04

Vijay has begun collecting data at this point. He is testing 3 concentrations of salinity and 3 levels of ultra violet radiation. Vijay is no longer testing photosynthetic production but will be testing levels of cell death based on color. He will develop a rating system for cell death to quantify his data. Vijay's initial results point to the higher level of ultra violet radiation leads to more cell death. Salinity does no seem to be affecting the cells very much at all. Vijay wants to perform as much replication as possible but is not sure how much time will allow for.

Update: 2/12/04

Not available

Mentor Recommendation:

It was recommended that Vijay perform an ANOVA test to analyze his data. This is a two factor test of variance that will show the relationship between the three levels of salinity and the three levels of ultra violet radiation.

Science Fair: 2/19/04

Project Title: The Effect on Spirulina Brought About by Current Trends in Environmental Change

Results: Qualified for the Regional fair.

4.3 Students not mentored

Sarah M.

Initial Project Description: 10/30/03

Title: The Effect of Temperature on the Index of Refraction of Glycerine II: Using Different Percentages of Glycerin

Description: I am using an adapted Michelson interferometer placing a small fish tank of glycerin in the optical path. I will heat the glycerin and let it cool as I take data. Mathematically I will then calculate the change in the index of refraction. This year I am dissolving the glycerin in to another substance at different percentages then using that in the spatial path.

Selection Process:

This project was not selected for mentoring because it is a complicated project and it is difficult to postulate results. This project deals heavily with modeling and would not fit into the scope of our project.

Science Fair: 2/19/04

Project title: The Effect of Temperature on the Index of Refraction of Aqueous-Glycerin Solutions

Result: Did not qualify for the Regional fair

Samko

Initial Project Description:

Title: Using Game Theory to Analyze a Situation

Description: I am going to use game theory to analyze a situation. The only data I expect to use is the background data on which my model will be based. Since I still do not have a specific topic, I do not have all the information necessary to know what data I will be testing.

Selection Process:

This projection was not selected for mentoring because it is exploratory. The student doesn't have a clear-cut project at this point and game theory, as a basis will most likely not benefit from the use of a statistical mentoring process.

Science Fair: 2/19/04

Project title: Game Theory as Analysis for Animal Behavior

Result: Did not qualify for the Regional fair

Caitlin

Initial Project Description:

Title: Using a piezoelectric polymers as sensor for a sleep apnea monitor for infants

Description: I am building a sleep apnea detection system and I will collect data on how effective the sensor works in different indoor conditions.

Selection Process:

This project was not chosen for mentoring because it will deal mostly with development and engineering. The time spent in development of the sensor system would not allow the project to participate in the

Science Fair: 2/19/04

Project title: An Environmental Inquiry: Local Levels of Deicing Salts and their Ecological Effects

Result: Did not qualify for the Regional fair

Paul

Initial Project Description: 10/30/03

Title: robot navigation in 3d

Description: Extending a method of subsumption into 3d, will be collecting data as to the time it takes for a robot to navigate from start to goal in an environment of increasing complexity.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: A Fuzzy Logic-Based System for the Navigation of Mobile Agents in Unknown Environments

Result: Did not qualify for the Regional fair

Isaac

Initial project description 10/30/03

Title: Determining the trajectory of a Soccer ball shot with the toe

Description: I will chart the flight of the ball in 3 dimensions. This will be done for lefty and righty kicks and different locations where the ball is kicked.

Survey

1. *What is the Goal of your Project?*
To determine the trajectory of a toe-ball in soccer.

2. *What result(s) do you expect?*
A formula relating power of a kick, location on ball, distance, displacement. This maybe multiple formulas, but hopefully can all be drawn into one relation.

3. *How will you determine if your project has been successful?*
If a formula is found it was a success

4. *Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?*
Displacement in each of the three directions.

5. *How do you plant to measure this quantity or concept?*
Using videopoint software – chart the path in 3 dimensions. Follow this and find a displacement or variance.

6. *Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.*

- Power of kick
- Where on the ball
- How much air is in ball
- Air resistance
- wind

Selection process

This student was not chosen because we believed that the building of the machine would take the majority of the time devoted for the project.

Science Fair: 2/19/04

Project title: The Flight of a Toe-Ball in soccer

Result: Did not qualify for the Regional fair

Rachel

Initial project description 10/30/03

Title: Engineering a devise to distinguish between FM music and talk

Description: I will be scanning about 50 pieces of music in search of patterns in frequency/amplitude/harmonics/etc.

I will measure the accuracy of the scanner based on trials of whether or not the scanner could distinguish

Selection process

This student was not chosen because we believed that the building of the machine would take the majority of the time devoted for the project.

Science Fair: 2/19/04

Project title: Audial Analysis of Music and Speech Characteristics

Result: Qualified for the Regional fair

Bethany

Initial project description 10/30/03

Title: How to distinguish stresses in a roller coaster

Description: I am going to build a roller coaster track and car. I am going to use stress gauges to record the amount of stress on the track. I will change the mass of the cart at points on the track to determine what effects stress on the track.

Selection process

This student was not chosen because we believed that the building of the course and cart would take the majority of the time devoted for the project.

Science Fair: 2/19/04

Project title: Structural Stress of Roller Coasters and How to Diminish it

Result: Qualified for the Regional fair

Brian

Initial project description 10/30/03

Title: Human powered catapult

Description: I am going to develop a human powered catapult and will be varying the force that throws a 10 pound weight

Selection process

This student was not chosen because we believed that the building of the catapult would take the majority of the time devoted for the project.

Science Fair: 2/19/04

Project title: Target Shooting Catapult

Result: Did not qualify for the Regional fair

Sam

Initial project description 10/30/03

Title: How can Mass Academy Broaden its range?

Description: I will collect data for what schools and cities Mass Academy students came from. I will also find out where Mass Academy advertised and with how much money.

Selection process

This student was not chosen because we believed that the project in itself was too much work for students doing the IQP to do by themselves. It required more expertise.

Science Fair: 2/19/04

Project title: Be Hip: Enhance Your Hip Protector

Result: Qualified for the Regional fair

Ashley

Initial Project Description: 10/30/03

Title: Preventing Tornado Damage

Description: I am going to design a new shelter for homes and/or large stadiums and venues. The shelter will be something to cover the existing building. I will test which material shape and way of engaging the shelter can withstand the highest winds and are strong enough to withstand debris.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help.

Science Fair: 2/19/04

Project title: Preventing Loss of Life Due to Tornadoes Hitting Large, Open Air Venues

Result: Did not qualify for the Regional fair

Jennifer K.

Initial Project Description: 10/30/03

Title: Effect of wavelengths of light on the energy produced by a photovoltaic cell.

Description: I am going to be sending waves of light of different wavelengths and measuring the energy expelled by the battery cell. I will need to measure the wavelengths of light, the energy normally expelled by the battery and the energy expelled by the battery with different wavelengths.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: The Effect of Wavelength and Color of Light Aimed at a Photovoltaic Battery Cell on the Energy Output of a Battery

Result: Did not qualify for the Regional fair

Brian Do.

Initial Project Description: 10/30/03

Title: Effect of environment on noise reduction.

Description: I am setting up an environment on noise reduction in which I will record the effects of sound reduction/cancellation. I will try to reduce noise and make the environment size larger.

Survey

1. *What is the Goal of your Project?*
My goal is find the most sound proof flexible material.

2. *What result(s) do you expect?*
I expect that I will find a light, sound proof material that will

3. *How will you determine if your project has been successful?*
It will be successful if I find a light, sound proof material fitting for a tent covering.

4. *Almost every project will involve the measurement of a quantity (e.g. distance, temperature, length,) or concept (e.g. comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?*
I will measure sound proofness, flexibility, cost and weight.

5. *How do you plant to measure this quantity or concept?*
For sound proof I will make an apparatus and compare stereo output to a microphone intake.

6. *Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.*

- Absorption
- Thickness
- Loudness of sound
- Structure-borne sound

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: An In-Tents Night's Sleep: Sound Reduction Properties of Flexible Materials

Result: Did not qualify for the Regional fair

Jacob

Initial Project Description: 10/30/03

Title: Driveway Heating System

Description: I am creating a driveway heating system that will be absorbed on top of the current driveway. I will be measuring the amount of snow that the system can melt and the temperatures that the system is effective.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: Portable Driveway Heating System

Result: Did not qualify for the Regional fair

Gwendolyn

Initial Project Description: 10/30/03

Title: safety enhancing thermochromics

Description: I am going to try and design a product that will enhance safety by changing color when it gets hot or cold. I imagine that I will need to measure the temperature at which it changes and find any inconsistencies in the data.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: Thermochromic Applications in the Arena of Burn Prevention

Result: Did not qualify for the Regional fair

Erin

Initial Project Description: 10/30/03

Title: designing better artificial snow

Description: I'm going to make more powdery artificial snow for ski slopes. I'll have to measure the way temperature and the amount of compression the skis put through affect the texture of the snow.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: Fold-a-Door

Result: Did not qualify for the Regional fair

Rosemary

Initial Project Description: 10/30/03

Title: Flute adaptation for a person with hand/finger impairment.

Description: I plan to make a device that will allow the flute to be played without physically pressing the keys. I will be using a system of levers and will measure their efficiency. I will also be trying to make the device as discrete (small) as possible.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: Mechanical Assistance for a Handicapped Flutist

Result: Did not qualify for the Regional fair

Alex

Initial Project Description: 10/30/03

Title: Adjustable bed

Description: I am attempting to build a more adjustable bed which is more comfortable than the other beds. I expect that I will need to test how comfortable the bed is how quiet the bed is, and how fast the bed moves to accommodate the customer.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: Adjustable Bed

Result: Did not qualify for the Regional fair

Brian T

Initial Project Description: 10/30/03

Title: engineering a floor-mounted CO2 releasing nozzle for fire suppression.

Description: I am looking to increase the time that it will take for both my engineered nozzle and a normal nozzle to extinguish a fire that is constant.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: Help From Below: Floor Mounted Fire Extinguishing System

Result: Did not qualify for the Regional fair

Mindi

Initial Project Description: 10/30/03

Title: how to reorient yourself in space

Description: I am experimenting with different distance equations and theories relating to space travel to create an ultimate formula (process) to become reoriented. There is no physical data, but many equations will need to be manipulated and worked around.

Selection Process:

This project was not chosen because it was going to be mostly formulation and would not have statistical date to manipulate.

Science Fair: 2/19/04

Project title: Reorientation in Deep Interstellar Travel (Lost in Space)

Result: Did not qualify for the Regional fair

Krishan

Initial Project Description: 10/30/03

Title: Video Conferencing on a PS2

Description: I hope to turn PS2s into a video conferencing tool that can be used over the internet with the PS2s network adapter. I will be measuring the quality and bitrate of the audio/video feed. I will most likely be using the Linux Developer's kit available for PS2.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: Videoconferencing on a PS2

Result: Did not qualify for the Regional fair

Ahn

Initial Project Description: 10/30/03

Title: Efficiency of medical masks

Description: I am trying to test how well a mask will filter out harmful substances. I plan to measure the amount of substances that will be left out after the filtration process. I then plan to take these results and make a mast that can filter even better.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: The Filtration Efficiency of Respiratory Masks

Result: Did not qualify for the Regional fair

Matthew

Initial Project Description: 10/30/03

Title: Pill Dispenser

Description: I am trying to make an automatic pill dispenser that will dispense the pills on the correct time of day. I will need to measure accuracy of time and also measure how long the power of the battery lasts.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: Pill Packer: An Automated Pill Dispenser

Result: Did not qualify for the Regional fair

Ariel

Initial Project Description: 10/30/03

Title: Bike shields for cars to increase gas mileage

Description: I am trying to create shields and test the aerodynamic efficiency of these shields. From the calculations I plan on making a full-scale model of this design. I will use the WPI wind tunnel for testing.

Selection Process:

This project was not chosen because it was going to be mostly engineering in nature and would not benefit from statistical help

Science Fair: 2/19/04

Project title: Aerodynamic Bicycle Shields

Result: Qualified for the Regional fair

5. Evaluations of Student Activities and Mentoring Program

5.1 Introduction

After the Science Fair projects were completed, an analysis of the mentoring program needed to be done in order to evaluate its success. The mentored students were given a survey after the science fair was completed to determine what, if anything, they learned from each activity and how useful the program was as a whole. The activities included in the survey are the Cookie Activity (Section 3.2) and the Cup Flipping Activity (Section 3.3). Before getting to the student responses, the mentor's thoughts on what actually happened should be expressed. The survey document that was used can be found in Appendix C. The survey results are included in Section 5.2

5.1.1 Cookie Activity – "What Really Happened"

The Cookie Activity for the most part went well. The number of students in the junior class, 50, was known ahead of time, so the Excel spreadsheet was prepared in advance (See Figure 3.1). Our goals during the presentation were to get the students to understand the basic concepts of statistics (See Section 2.2) and some basic methods of analysis. Another goal was to show the students the uses of Microsoft Excel and how to do some of the Data Analysis functions.

The presentation began by introducing the mentors and briefly explaining what we planned on doing with them throughout the year. The presentation slides (See Appendix A) were given in order and each topic was briefly explained. It was assumed that the students did not have any previous statistical background and also taken into account that there was a lot of information to go through in the presentation, so the attempt was made to give enough description for the students to get a grasp on the subject, but not too much to be able hold in the entire presentation.

For the activity, the students were split in half (left side and right side of the class) and each student were given two cookies. Each student on the left side was given two generic cookies (Price Chopper brand to be exact) and the students on the right were given Chips Ahoy cookies. They were asked to count the chocolate chips in each cookie and to record their data. Once the students had finished counting chips, they were recorded by a mentor into the prepared Excel spreadsheet. At this point, things started to go wrong.

The analysis of the data was not able to be done right away because no one had checked to make sure that the Data Analysis option was available from the Tools menu (See explanation and Figure 3.7 from the Cookie Activity section). At this point, there was no preparation to continue the analysis without the aid of Excel, and the mentors were stuck trying to answer questions that were not necessarily prepared for. Briefly showing some of the concepts of analysis on the chalkboard was attempted, but as stated above, there was no preparation.

The laptop that was being used had to be replaced because it didn't have a connection to the network, which was needed to download the Data Analysis Toolpak. Once the new laptop was in place and the Toolpak was installed, the analysis was able to be shown through Excel. After explaining the analysis, the presentation slides continued and were concluded. After the presentations, questions were fielded from the students. Another thing that was not prepared for was the level of statistical knowledge some of the students had. Being under the impression that all of the students had little to no understanding across the board, the mentors were quite surprised by some of the questions.

5.1.2 Cup Flipping Activity – "What Really Happened"

1) Using names drawn from a hat, the students were split into two groups, Group A with 7 and Group B with 8.
2) We explained what the exercise was and how it was to be completed and we gave a brief demonstration.
3) Group A was instructed to do the flip cup exercise with their non-dominant hand, all students doing the activity simultaneously. The results were recorded into an Excel spreadsheet.
4) Group B, at the same time, was instructed to flip a coin to see which hand, dominant or non-dominant, they would use first. Results were recorded.
5) Both groups repeated this activity with the opposite hand that they had previously used. Results were recorded.
6) Groups A and B were then given the assignments of the opposite group – Group B started with the non-dominant hand and then did a fourth trial with the dominant while Group A flipped a coin for the third trial and then used the opposite hand for the fourth. Results were recorded.
7) We then explained the usefulness of the activity – How we used randomization and why.
8) The results were varying in the individual trials of the different students. We were able to show, by displaying the mean of each trial and then the mean of all the trials by both groups, that the average number of flips by either group was very close to the same (by less than 1 flip per trial). We concluded that the randomization of the groups and how they did the activity enabled more accurate results. Also, by increasing the number of trials the end result for both groups were very similar, showing that more trials made a more accurate experiment.

The experiment took place at 8am and may have affected the usefulness of the activity. The students were distracted easily as it seemed to be a fun activity and the cups being flipped were making a loud noise. Taking the cups away at the end so that the results could be displayed helped in being able to conclude the activity. There was very little feedback from the students as to whether what we were doing made sense to them, but it was an easy concept and that may have been a factor.

5.2 Post-Mentored Student Survey Results

These responses were kept anonymous.

Project Evaluation Questionnaire 1

1) *Was the chocolate chip cookie activity helpful? What did you learn from it?*
   It was a little helpful. I learned how to use Excel a little better.

2) *Was the cup flipping activity helpful? What did you learn from it?*
   This was fun. It showed how results can be skewed and differs from what's expected.

3) *Did you receive enough help with you Science Far Project?*
   I got some help. It was useful if I had used it. I ran out of time so didn't really get to do what you told me.

4) *What did you like about this project?*
   It was fun and gave me something to do. It also helped me get concrete ideas.

5) *How could this project be improved?*
   I think it could be a little more organized. A lot of the time, you tried to do things but either did have the right equipment or enough time.

6) *Would you recommend this project be done again next year?*
   Yes

Project Evaluation Questionnaire 2

1) *Was the chocolate chip cookie activity helpful? What did you learn from it?*
   This activity was somewhat helpful because it showed how to use excel with large amounts of data and generalizing it.

2) *Was the cup flipping activity helpful? What did you learn from it?*
   Not really because I don't remember what the point was.

3) *Did you receive enough help with you Science Far Project?*
   Yes I received helpful ideas and advice with my project,

4) *What did you like about this project?*
   I liked that we had other people to help us specifically with quantifying the data.

5) *How could this project be improved?*
   It could be improved by having a lesson with using excel to make different graphs.

6) *Would you recommend this project be done again next year?*
   Yes, if it focused a lot on visualizing the data.

Project Evaluation Questionnaire 3

1) *Was the chocolate chip cookie activity helpful? What did you learn from it?*
   Yes because I learned how to analyze the significance of a difference in chocolate chips.

2) *Was the cup flipping activity helpful? What did you learn from it?*
   I can't remember it.

3) *Did you receive enough help with you Science Far Project?*
   Yes

4) *What did you like about this project?*
   I did not think that I learned much that I did not know about.

5) *How could this project be improved?*
   If there were more real things and not as many metaphorical things.

6) *Would you recommend this project be done again next year?*
   Not really because it did not help me.

Project Evaluation Questionnaire 4

1) *Was the chocolate chip cookie activity helpful? What did you learn from it?*
   Yes the chocolate chip was useful because I now understand the significance in the range of data

2) *Was the cup flipping activity helpful? What did you learn from it?*
   I was not there.

3) *Did you receive enough help with you Science Far Project?*
   Yes I did.

4) *What did you like about this project?*
   I liked the statistical analysis. It taught me some useful aspects of data analysis

5) *How could this project be improved?*
   A demonstration of more statistical techniques.

6) *Would you recommend this project be done again next year?*
   Yes

Project Evaluation Questionnaire 5

1) *Was the chocolate chip cookie activity helpful? What did you learn from it?*
   Yes I learned about data collection and analysis.

2) *Was the cup flipping activity helpful? What did you learn from it?*
   Yes, I learned that doing things in a random order is important.

3) *Did you receive enough help with you Science Far Project?*
   Yes I did

4) *What did you like about this project?*
   It gave me resources and help with my project that I would not necessarily have had otherwise.

5) *How could this project be improved?*
   That could have taught us more about the actual statistics.

6) *Would you recommend this project be done again next year?*
   Yes

Project Evaluation Questionnaire 6

1) *Was the chocolate chip cookie activity helpful? What did you learn from it?*
   Yes it showed how to do analysis in Excel and how to use T-tests

2) *Was the cup flipping activity helpful? What did you learn from it?*
   I think it was pretty much the same as the chocolate chip cookie activity.

3) *Did you receive enough help with you Science Far Project?*
   Yes I received lots of help with my project.

4) *What did you like about this project?*
   It was interesting. The cookie and cup activities made it easier to understand.

5) *How could this project be improved?*
   Show us how to analyze data more, like with different type of tests.

6) *Would you recommend this project be done again next year?*
   Yes

Project Evaluation Questionnaire 7

1) *Was the chocolate chip cookie activity helpful? What did you learn from it?*
I liked eating cookies....but it did actually help a lot in seeing how data sampling is important

2) *Was the cup flipping activity helpful? What did you learn from it?*
Not really, I don't really remember it.

3) *Did you receive enough help with you Science Far Project?*
I didn't need as much statistical analysis as some people so I didn't really need help, but the help I got was enough.

4) *What did you like about this project?*
I liked that if I had problems with statistics there was someone I could go to for help.

5) *How could this project be improved?*
Maybe just concentrating more on t-tests, etc. after data was taken instead of before

6) *Would you recommend this project be done again next year?*
Maybe for people who really need it, I didn't need it too much

Project Evaluation Questionnaire 8

1) *Was the chocolate chip cookie activity helpful? What did you learn from it?*
Yes, showed the value of a t-test in analyzing large amounts of data.

2) *Was the cup flipping activity helpful? What did you learn from it?*
I don't remember the cup game.

3) *Did you receive enough help with you Science Far Project?*
Yes. You did all you could.

4) *What did you like about this project?*
It was helpful to my project.

5) *How could this project be improved?*
More activities.

6) *Would you recommend this project be done again next year?*
Yes.

Project Evaluation Questionnaire 9

1) Was the chocolate chip cookie activity helpful? What did you learn from it?
The chocolate chip cookie activity was helpful in learning about t-tests.

2) Was the cup flipping activity helpful? What did you learn from it?
It wasn't as effective as the cookie activity it covered the same material as the t-tests in the cookie activity.

3) Did you receive enough help with you Science Far Project?
I received help and advice about analyzing the data for my project.

4) What did you like about this project?
The project was interactive and helped me to learn about the t-test.

5) How could this project be improved?
The selection of people to be used could be modified. Most people didn't really need to use the t-test analysis.

6) Would you recommend this project be done again next year?
Yes with modifications.

Project Evaluation Questionnaire 10

1) Was the chocolate chip cookie activity helpful? What did you learn from it?
The chocolate chip cookie activity was memorable and I learned the way to compare data.

2) Was the cup flipping activity helpful? What did you learn from it?
I missed the cup flipping activity.

3) Did you receive enough help with you Science Far Project?
I think I received enough information to compile my data.

4) What did you like about this project?
The project was very interactive.

5) How could this project be improved?
The project could be improved by developing reasoning for the analysis, and an explanation of the different types to analyze data.

6) Would you recommend this project be done again next year?
Yes, I would recommend this project be done again next year.

Project Evaluation Questionnaire 11

1) Was the chocolate chip cookie activity helpful? What did you learn from it?
It was interesting but also a bit distracting because we were more concerned about the cookie.

2) Was the cup flipping activity helpful? What did you learn from it?
The cup flipping was fun but I don't remember anything.

3) Did you receive enough help with you Science Far Project?
Yes I did.

4) What did you like about this project?
It was interesting but sometimes the point wasn't clear.

5) How could this project be improved?
This project could have more explanations.

6) Would you recommend this project be done again next year?
Yes I do.

Project Evaluation Questionnaire 12

1) Was the chocolate chip cookie activity helpful? What did you learn from it?
The activity was helpful in that it introduced the t-test, which was valuable to my project. I think it was a little unnecessary to go through all the work with cookies although we did get out of real class.

2) Was the cup flipping activity helpful? What did you learn from it?
Ehh is my first idea. It got the point across experimentation should be blind. I am inclined to say it was unnecessary and should be left out.

3) Did you receive enough help with you Science Far Project?
Yes, the t-test was helpful.

4) What did you like about this project?
t-test

5) How could this project be improved?
More of meaning and understanding of statistics and why the t-test works, other possible tests. What each result means in t-test.

6) Would you recommend this project be done again next year?
Yes

Project Evaluation Questionnaire 13

1) Was the chocolate chip cookie activity helpful? What did you learn from it?
Yes it shows discrepancies and how to analyze and sort data.

2) Was the cup flipping activity helpful? What did you learn from it?
Not really, we got off focus and did not learn much.

3) Did you receive enough help with you Science Far Project?
Yes.

4) What did you like about this project?
That it helped identify variables.

5) How could this project be improved?
By dealing with individuals.

6) Would you recommend this project be done again next year?
I think the concept worked well, but the actual class needed to be more oriented.

Project Evaluation Questionnaire 14

1) Was the chocolate chip cookie activity helpful? What did you learn from it?
Yes, it showed us how to use excel to collect, organize, and analyze data.

2) Was the cup flipping activity helpful? What did you learn from it?
Yes it showed that changing your process can change the results so be consistent.

3) Did you receive enough help with you Science Far Project?
Yes.

4) What did you like about this project?
It helped me to understand and analyze the meaningless data collected.

5) How could this project be improved?

6) Would you recommend this project be done again next year?
Yes.

5.3 Conclusion

The Cookie Activity as a whole was a great success to the mentored students. Most seemed to remember the concepts presented in the post-mentoring survey. They liked the idea that they could take sets data and now show how significant that data was. They also really seemed to like getting a lesson in Microsoft Excel and being able to do this kind of data analysis in a program that they were all familiar with. The Cup Flipping Activity did not see that kind of success. Some of the students got the point about randomization and replication and that by doing so will enhance the results of their experiment. Most of the students, however, either didn't remember what the point of the activity was, or don't remember it at all. They remembered that it was fun and that they were out of class, but did not retain much from it. If this activity was to be repeated, it would be suggested to not do it at 8am because the attention span of the students at that time may have been a factor in their remembering the experiment.

The students as a whole really seemed to feel that they were helped by this project. Most responding students expressed approval of what the mentors were trying to do and that their projects were positively affected by it. The students that did not receive much help throughout the project either expressed that they would not recommend the project to continue because it did not help them or that it should be continued for those that needed the help. The students that received help, which was the majority, indicated that they would recommend that the project be continued. Most students feel that more activities might help in understanding more fully the reasons for doing some of the design and analysis. It was also suggested that more individual time with students might be helpful.

6. Discussion

6.1 Project Summary

This project started out as an idea by the teachers of Mass Academy and Professor Wilbur. They believed that the Science Fair projects could be improved with the application of statistical designs and individual mentoring. The students were selected to be mentored and they were given advice and were able to ask questions.

6.2 Recommendations for Mass Academy and High School Teachers

We recommend that the selected students be advised to start working on their science fair projects and obtaining data as soon as possible so that problems with collecting data and project changes can be identified as soon as possible so that the mentor's can prepare accordingly and present the students with the relevant material with ample time prior to the science fair.

6.3 Recommendations for Future IQP's

For future IQP's , the group should first schedule a meeting with the teachers that serve as the contacts for the IQP group at Mass Academy and discuss the weekly floating schedule that the academy operates on. Then the IQP group should obtain the schedule of completion for the student's science fair projects from the teachers and plan the presentations and activities accordingly.

The IQP group should plan a couple of presentations and activities prior to the selection of the mentored students so that they can begin working with the students and presenting them with a background in statistics as soon as the selection process is complete.

6.4 Conclusion

After Science Fair projects had been judged and the Regional fair qualifiers were announced, it became obvious that the students that had been mentored had the advantage over the non-mentored students. The students who were mentored made up half of the total number of students that were to be sent to the next level. The majority of students felt that the project should be repeated the next year, which indicates that the students benefited from the program and that it was successful.

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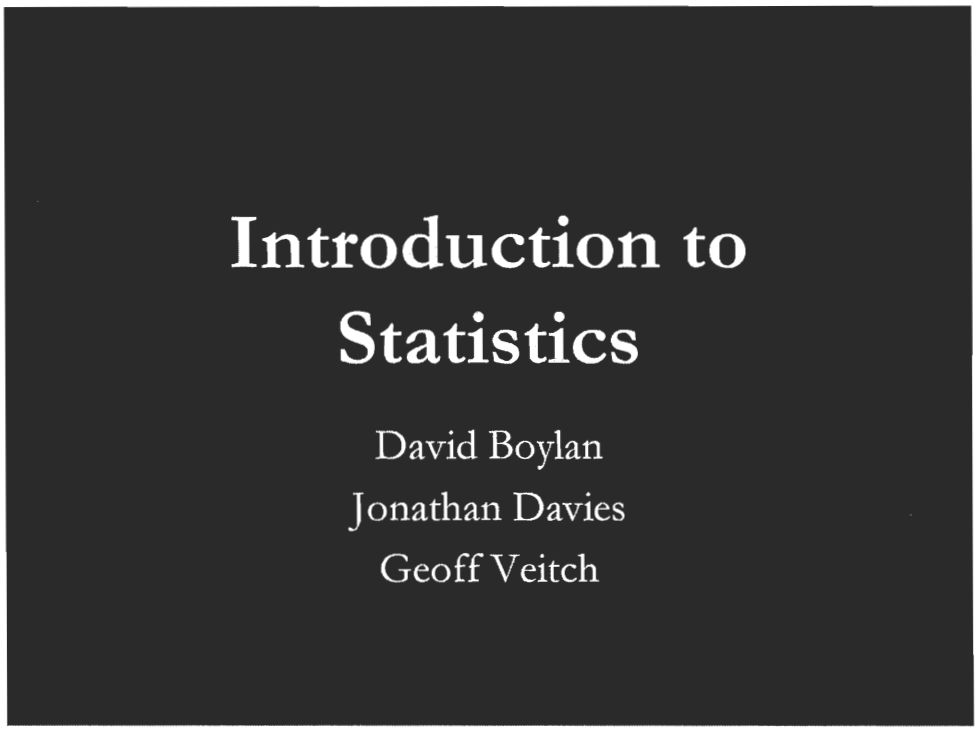
Internet WWW Page at URL:
http://www.massacademy.org/

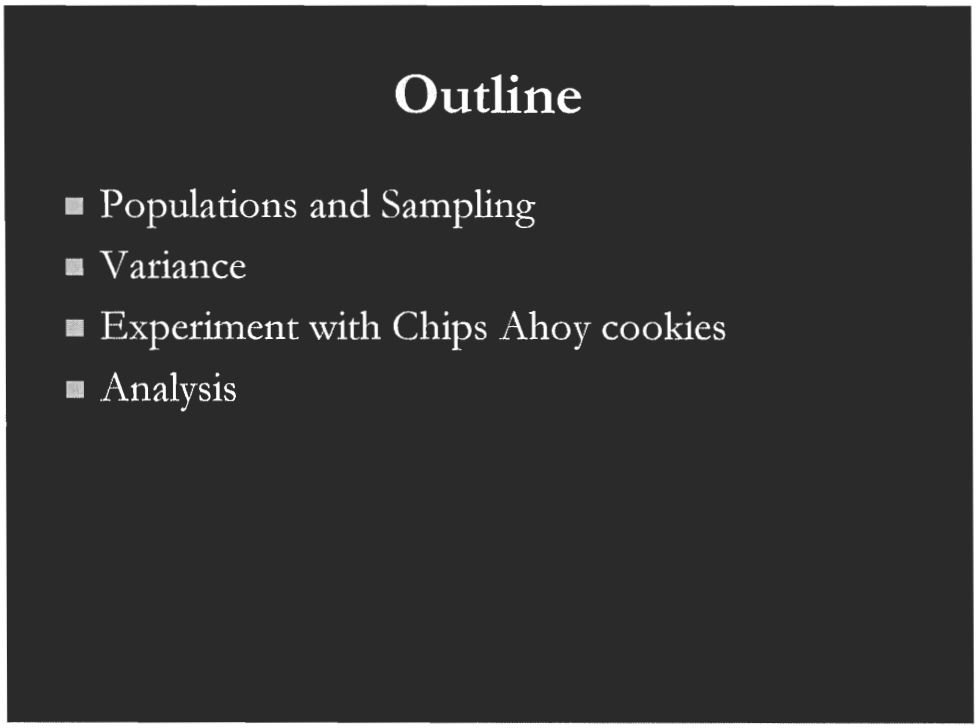
SAS Manual for PROC FREQ used for Cochran-Armitage test
Internet WWW Page at URL:
http://www.math.wpi.edu/SASpdf/stat/chap28.pdf

F-test overview
Internet WWW Page at URL:
www.davidmlane/hyperstat/intro_ANOVA.html

WPI IQP Handbook
Internet WWW Page at URL:
http://www.wpi.edu/Academics/Depts/IGSD/IQPHbook
(Current version as of June 28, 2001 12:39 EDT)

APPENDIX A: PowerPoint Slides for Introduction to Statistics Presentation





Definition

- Data: Facts that can be analyzed in order to draw conclusions or make decisions.

Definition

- Information: processed representation of data.

Definition:

- Statistics: the science of data
  - How to obtain it
  - How to analyze it
  - How to interpret it

Where are they used?

- Statistics are important to many professions, including engineering, science, medicine, business, and industry.

Where does data come from?

- Population: the collection of all samples from which conclusions can be drawn
- Sample: Subgroup of the target population from which observations and measurements can be made to draw conclusions about the target population.

Sampling

- Population: All people who can vote
- Sample: 1000 voters who have taken a survey

Sampling Variability

- Between
  - Variation of the results from one group of data to the next
- Within
  - Variation of the results inside one group of data

Sampling Variability

- Between:
  - Gas mileage of a Ford F150 vs. a Dodge Ram
- Within:
  - Gas mileage of Ford F150s vs. other Ford F150s

Experiment
Chips Ahoy vs. Generic

- Goal: to compare the number of chocolate chips within each brand and also between the two.
- Hypothesis: Chips Ahoy does not have the same amount of chocolate chips as the generic brand does.

Statistical Analysis

- Mean: the arithmetic average of a set of observations.
  - Total number of chips in the Chips Ahoy cookies divided by the number of cookies in the sample.
  - A measure of location

Statistical Analysis

- Standard Deviation: A measure of within variance
  - Measures the spread of a population
  - Shows an average of how far the samples are from the mean of the population

Statistical Analysis

- Histogram: Graph that shows how a population is distributed.

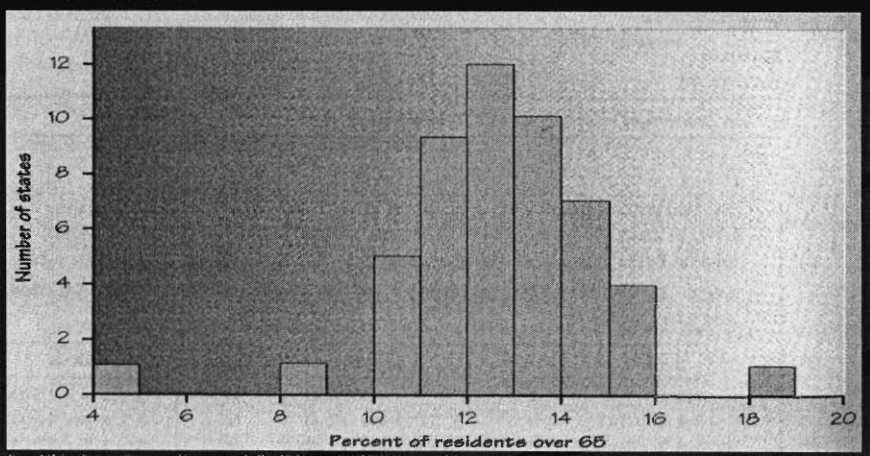


Figure 4.13 from Statistics: Concepts and Controversies by David S. Moore. ©1997 W.H. Freeman and Co.

Statistical Analysis

- T-Test: a measure of the significance of the results of the experiment.
- Critical Value: Value (given by Excel) that determines how significant the results are.

Summary

- Populations and samples
- Variance
- Analysis through T-tests

APPENDIX B: Mass Academy Science Project Questionnaire

Name: _____

Please answer all questions to the best of your knowledge.

What is the goal of your project?

What result(s) do you expect?

How will you determine if your project has been successful?

Almost every project will involve the measurement of a quantity (e.g., distance, temperature, length) or concept (e.g., comfort, preference, behavior, health, performance) of interest. What is the primary quantity or concept you are trying to measure in your project?

How do you plan to measure this quantity or concept?

Try to list as many different factors as possible that might influence the value and/or measurement of this quantity or concept.

APPENDIX C: Student Project Evaluation Questionnaire

1. Was the chocolate chip cookie activity helpful? What did you learn from it?

2. Was the cup flipping activity helpful? What did you learn from it?

3. Did you receive enough help with your Science fair project?

4. What did you like about this project?

5. How could this project be improved?

6. Would you recommend this project be done again next year?