Using Self-Experimentation to Motivate Students in Health Statistics

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Course and Audience

- Course:
- *Statistics for the Health Sciences*
- Audience:
- Preprofessional students in nursing and other health related fields such a histology, respiratory therapy and radiology.

Central Idea and General Goals

- Help students differentiate between various population parameters.
- Add salience to *Health Statistics* by performing tests using their own data.
- Critically analyze various sampling techniques.
- Convince students of the efficacy and importance of hypothesis testing.

Initial Project Deployment

- Students were intimidated when they first learned of the project.
- Their first step was to collect the sample data.
- As part of their feedback they were asked
- What sampling method is being used?
- What type and level of data re you collecting?

Determining the Hypothesis Tests

- The hypothesis tests and their claims came from one of three sources.
- 1. Published results.
- 2. Student presuppositions.
- 3. Spirous claims and “wives’ tales.”

Core Student Responsibilities

- For a given project students are to…
  - ✓collect appropriate data.
  - ✓identify the population parameter being tested.
  - ✓Determine which hypothesis test to use.
  - ✓write the null and alternative hypothesis and identified which hypothesis was begin claimed.
  - ✓compute the appropriate test statistic, p-value or confidence interval.
  - ✓make a decision and write a conclusion about the hypothesis test.

Project Follow Up Questions

- What sampling technique did you use?
- What type of data and what level of data were used for your project?
- Did measuring techniques affect the accuracy or precision of your sample data?
- How could the type of sample data that you gathered by ‘artificially’ generated?
- If you could do the project again, what would you change?
- If one were to question the validity of your results, what could be the basis of that claim?

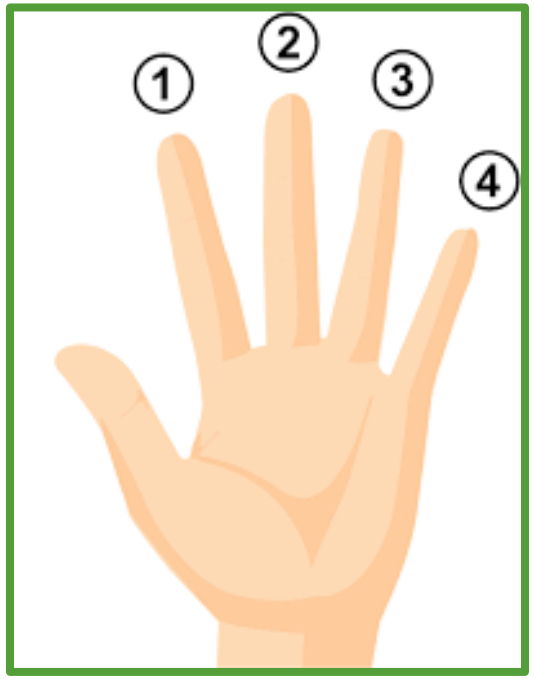
Sample Self-Experimentation Project – Background

- A person's peripheral capillary hemoglobin oxygen saturation (SpO_2) value is a measure of oxygen saturation.
- A patient's SpO_2 level is measure using a pulse oximeter and is measure in millimeters of mercury (mmHg).
- Test the claim that a person's SpO_2 level reading is the same, regardless of the finger that is begin tested.

Sample Self-Experimentation Project – Sample Collection

- Fingers are labeled L1, L2, L3, L4, R1, R2, R3, R4.
- The SpO_2 level reading was recorded for each finger on each hand for a 10 day period for a total of 80 measurements.
- The sample data is shown.

Date	L1	L2	L3	L4	R1	R2	R3	R4
6/17	97	99	98	98	97	99	96	98
6/18	98	98	97	98	99	98	98	98
6/19	97	97	98	93	98	96	97	97
6/20	97	96	97	98	97	97	99	97
6/21	96	99	95	98	99	99	97	94
6/22	98	99	98	94	99	98	97	97
6/23	95	97	98	97	97	97	98	97
6/24	98	97	98	98	98	98	98	98
6/25	96	96	98	97	97	96	95	97
6/26	95	96	96	97	98	96	99	97



Sample Self-Experimentation Project – ANOVA Results

- H_0: There is no difference in the mean SpO_2 levels for each finger measured.
- H_A: At least one mean SpO_2 levels mean is different than the others.
- Note: For this project H_0 represents the claim and a level of significance of $\alpha = 0.10$ was used.

Analysis of Variance results:
Data stored in separate columns.

Column statistics

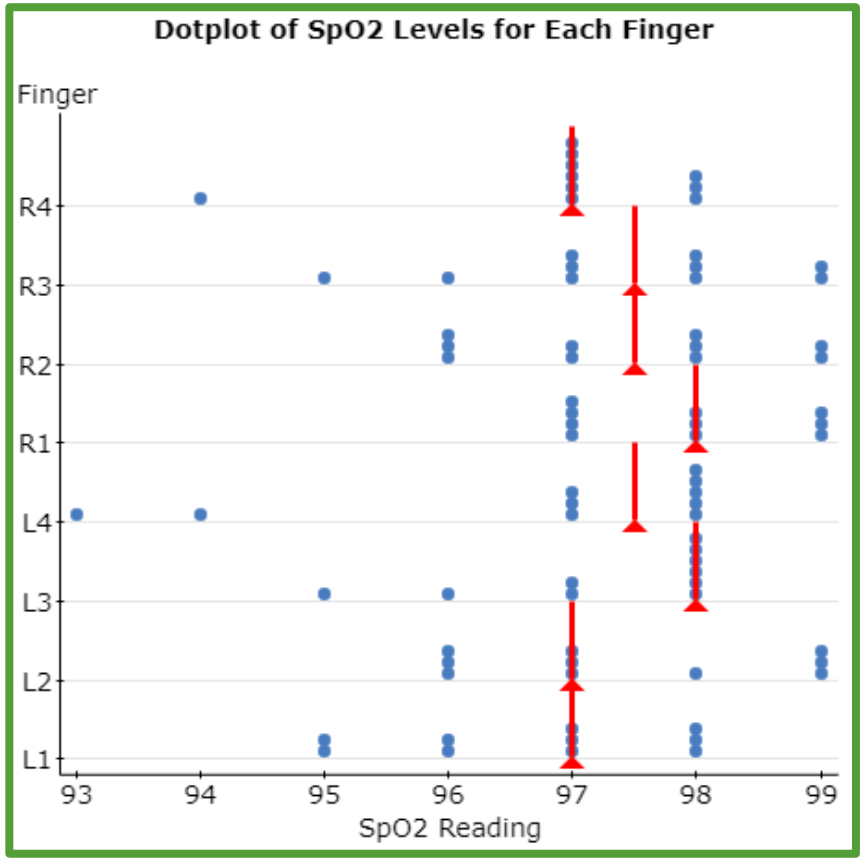
Column	n	Mean	Std. Dev.	Std. Error
L1	10	96.7	1.1595018	0.36666667
L2	10	97.4	1.2649111	0.4
L3	10	97.3	1.0593499	0.33499585
L4	10	96.8	1.8135294	0.57348835
R1	10	97.9	0.87559504	0.27688746
R2	10	97.4	1.1737878	0.37118429
R3	10	97.4	1.2649111	0.4
R4	10	97	1.1547005	0.36514837

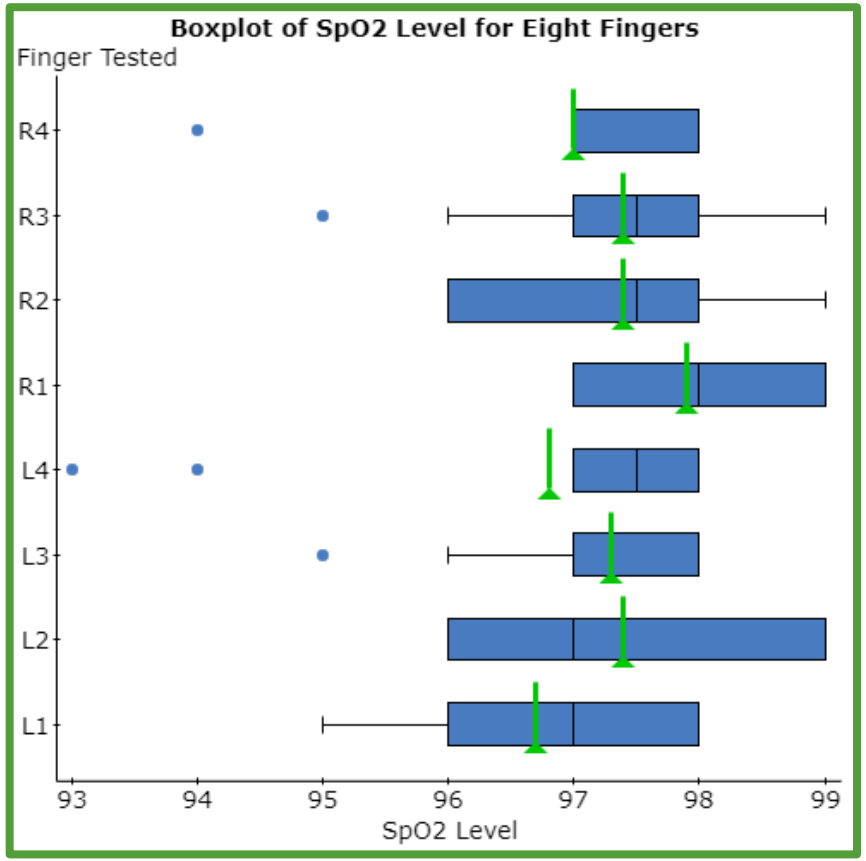
ANOVA table

Source	DF	SS	MS	F-Stat	P-value
Columns	7	10.5875	1.5125	0.97319035	0.4574
Error	72	111.9	1.5541667		
Total	79	122.4875			

Sample Self-Experimentation Project – Sample Visualization

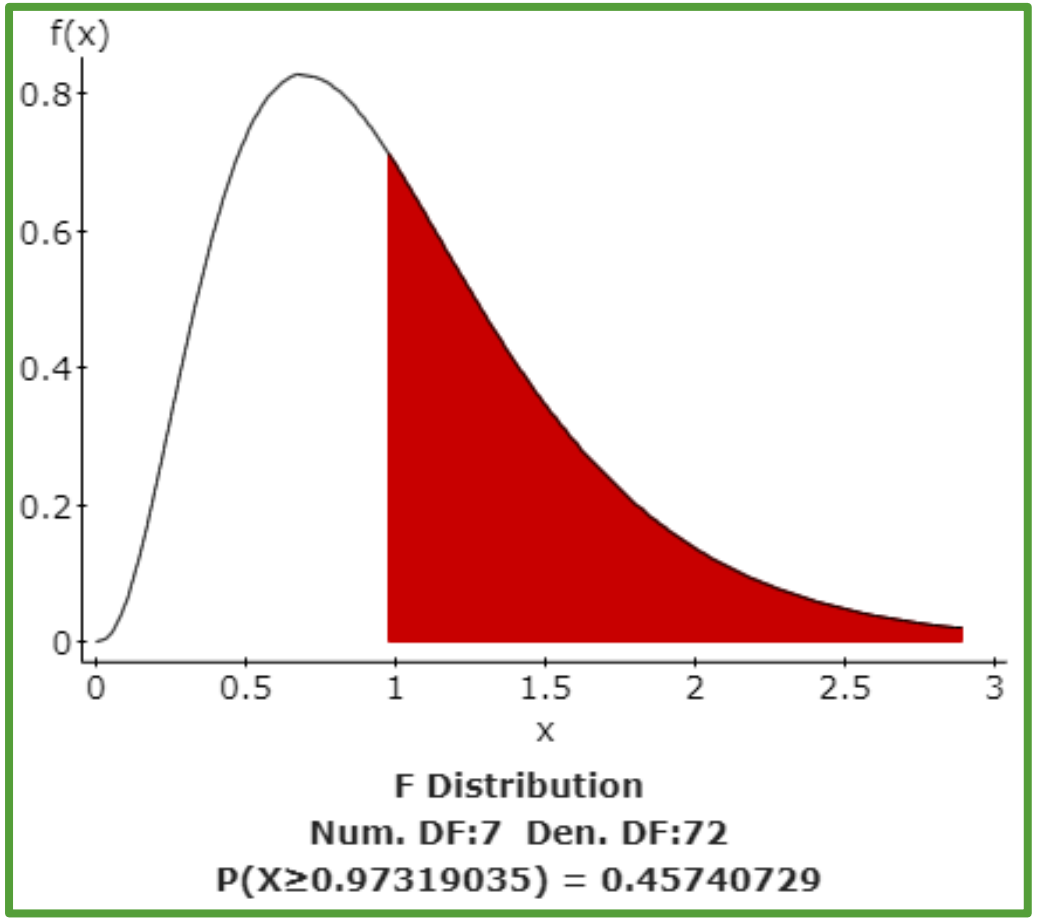
- This sample data was graphed using a dotplot and a series of stacked boxplots.





Sample Self-Experimentation Project – ANOVA Results

- Then an F-Distribution graph and results summary was submitted.
- Decision: Since the P-value (0.9732) is not less than α, we fail to reject H_0.
- Conclusion: There is not sufficient sample evidence to warrant rejection of the claim that there is no difference in the mean SpO_2 levels for each finger measured.



Sample Self-Experimentation Project – Follow Up Comments

- The student noted that…
  - the sample data was continuous, even though only whole number values were recorded.
  - the results could have been affected because the SpO_2 levels were only measured to the nearest whole number percentage.
  - a more precise pulse oximeter could give more exact results.
  - if repeating the project, factors such as the time of day measurements were taken and time proximity to physical activity could be taken into consideration.

Survey of Other Self-Experimentation Projects – Testing the Difference of Dependent Samples

- MedHelp.org claims that one's mean pulse rate is, on average, about 5.5 bpm slower in the morning as compared to the afternoon.
- Test the claim at a 1% level of significance.
- 15 morning and 15 evening measurements were taken.
- H_A: $\mu_D < 5.5$ bpm

Survey of Other Self-Experimentation Projects – Hypothesis Test for a Population Mean

- Some believe that people are more sedentary during the weekends.
- Test the claim that there is no difference in the average number of steps walked during week days and the weekends.
- Use a pedometer to record the number of steps walked on Tuesday, Wednesday, Saturday and Sunday for three weeks

Survey of Other Self-Experimentation Projects – Hypothesis Test for a Population Mean

- Some people call sitting the “new smoking.’
- Ipsos Social Research claims that the average person sits 10 hours per day.
- Test the claim at a 10% level of significance.
- Log the number of hours and minutes you sit each day for 15 days. Include driving and napping hours in the sitting total.
- H_0: $\mu = 10$ hours

Survey of Other Self-Experimentation Projects - Hypothesis Test for a Population Proportion

- National Public Radio conducted a survey and found that the proportion of days that a person washes their hair is 68.4%.
- For 30 consecutive days, record whether or not you wash your hair.
- Test the claim at a 5% level of significance.
- H_0: $p = 0.684$

Survey of Other Self-Experimentation Projects – One Way Analysis of Variance

- Test the claim that the amount of water consumed each weekday is the same, regardless of the day.
- Record the amount of water consumed each weekday for five weeks.
- Use a 10% level of significance.
- H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

Survey of Other Self-Experimentation Projects – Chi-Square Analysis

- This was a student-initiated project.
- Test the claim that sending texts or emails is independent of the time of day.
- In the morning and in the evening, record if you sent a text or an email.
- Record the responses for 15 consecutive days.

	Morning	**Evening**
Text Sent		
Text Not Sent		

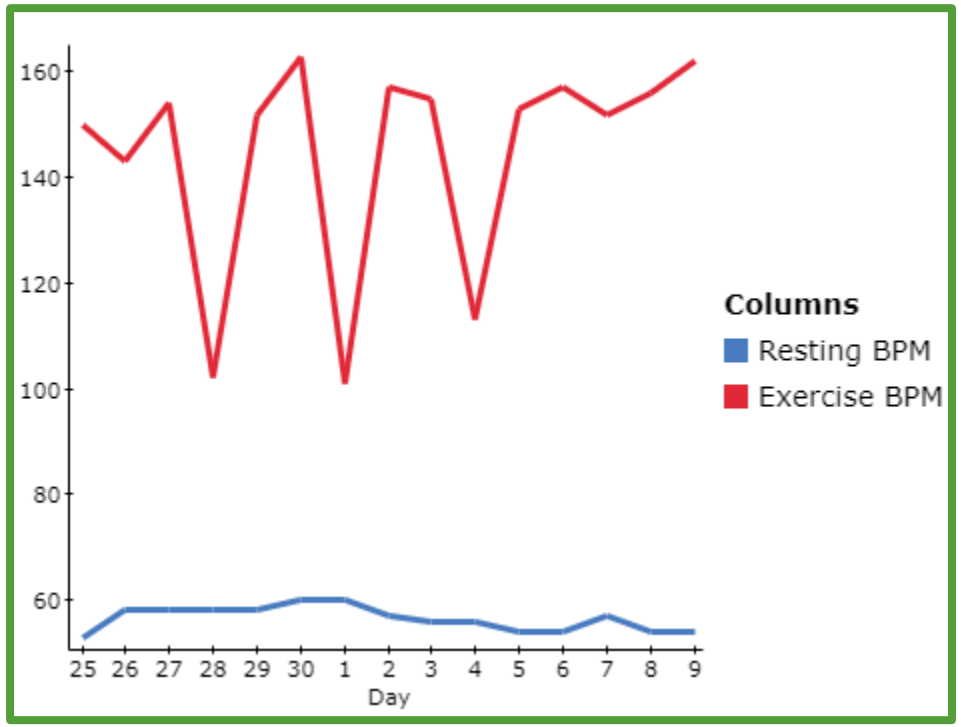
	Morning	**Evening**
Email Sent		
Email Not Sent		

Survey of Other Self-Experimentation Projects – Nonparametric Methods

- Test the claim that the median Brief Mood Introspection Scale (BMIS) scale value is lower in the morning than during the evening.
- Every morning and in the evening, record your mood every data for 15 days. Use the Brief Mood Introspection Scale (BMIS) scale where..
- -2-miserable, -1- unpleasant, 0-neutreal, 1-pleasant, 2-elated.
- Use the Wilcoxon Signed Ranks Test with $\alpha = 0.10$

Results of a Self-Experimentation Project – Testing the Difference of Means

- The Mayo Clinic says that the difference in resting and exercises heart rates is, on average, 76 beats per minute.
- Record your resting and exercise heart rate for 15 days.
- Use a 5% level of significance.
- A time sequence graph showed the difference in the resting and exercise pulse rates.



Results of a Self-Experimentation Project – Testing the Difference of Means

- For this project H_0: $\mu = -76$ bpm.
- The results are shown.
- Since the computed p-value < α, the null hypothesis is rejected.
- There is sufficient sample evidence to support rejection of the claim that the difference in resting and exercise pulse rates is 76 bpm.

Paired T hypothesis test:

$\mu_D = \mu_1 - \mu_2$: Mean of the difference between Resting BPM and Exercise BPM

$H_0 : \mu_D = -76$

$H_A : \mu_D \neq -76$

Hypothesis test results:

Difference	Mean	Std. Err.	DF	T-Stat	P-value
Resting BPM - Exercise BPM	-88.2	5.6805432	14	-2.1476819	0.0497

Take-Aways

- In compared to a typical class, the participating students…
- gave extra attention to the level of data began collected.
- took the project quite seriously.
- scrutinized the exactness of measures.
- created a serendipitous effect.

For More Information

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