Semester:
Fall 2016 – Wednesday Sections
• 12:45 in Phillips 416 – Section 11
• 6:10 in Government 101 – Section 12

Instructors:
Bill Adams (adams@gwu.edu)
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Hours: 5:00-6:00 Wednesdays and Thursdays

Chris Carrigan (ccarrigan@gwu.edu)
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Hours: 5:00-6:00 Wednesdays and Thursdays

SPSS Lab:
Amanda Roache (amandaroache@gwu.edu)
Lab location: Rome B104

Textbooks & Software:
• SPSS 22-24 (available in GW computer labs).
• Many other online readings and class handouts.

Assignments and Grades:
Sections 11 and 12 are divided into two parts:
Part 1 (Research Methods with Bill Adams) and
Part 2 (Applied Statistics with Chris Carrigan).

• The final examination for Part 1 counts 35% and will be held on October 19.
• The final examination for Part 2 counts 35% and will be held on December 14.
• Additional assignments for Part 1 count 5%.
• Additional assignments for Part 2 count 5%.
• The final report for Part 2 counts 20%.

• Class attendance is crucial and is required; no more than one unexcused absence.
• If for any reason a class is missed, in whole or in part, please obtain all announcements and assignments (especially those due at the next session), along with class notes and handouts, from your class colleagues before the next class.

Learning Objectives:
PPPA 6002 focuses on practical skills for conducting and evaluating empirical and quantitative research, plus a brief look at qualitative methods. The course explores the strengths and weaknesses of experimental (RCT), quasi-experimental, and nonexperimental research. It also covers the widely used statistical software, SPSS, and foundational univariate, bivariate, and multivariate statistics.

In particular, the course targets as learning objectives key research skills including how to:
Skill 1: Conduct and evaluate survey research
Skill 2: Conduct and evaluate RCTs
Skill 3: Conduct and assess other methods such as NEC, time series designs, correlational designs
Skill 4: Conduct and evaluate qualitative studies
Skill 5: Conduct statistical analyses using SPSS
Skill 6: Analyze basic univariate statistics
Skill 7: Implement bivariate statistical techniques including t-tests, chi square, correlation, and regression
Skill 8: Implement multivariate statistical techniques including multiple regression and partial tables analysis
Skill 9: Prepare a policy research report summarizing statistical analyses for a non-technical audience
Part 1: Additional Information (Adams)

Class Web Site: At gw6002.blogspot.com, the instructor will post important updates and links to online readings for Part 1 of this course. Please subscribe, and be sure to check on the weekend and again before the class. Blackboard is used too.

Weekly Steps:

1. To stay on top of the material, each week before class it will be valuable to internalize concepts listed on the syllabus and covered in the prior session. Identify any that need clarification.
2. Study assigned chapters, links, and other supplemental readings that were introduced in prior class session. If you also want to skim over readings for the new material that is entirely optional.
3. At the class web site (gw6002.blogspot.com), read the week’s new posts and the linked readings to recent items on the internet as well as those posted in Blackboard.
4. Submit weekly worksheet answers via Blackboard (at least 1 hour before class). Answers should be concise but usually more than a couple of words.
5. Be sure to bring a copy of the worksheet questions as well as your answers to class for discussion.

Grading: Lowest overall Part 1 grade (no rounding) for an A is 94.00; A− 90.00; B+ 87.00; B 83.00; B− 80.00; C+ 77.00; C 73.00; and C− 70.00.

Part 1 Examination (October 19): This exam is closed-book (no extra notes and no calculator). It consists of short objective questions (not broad essays) focusing on understanding and applying the concepts listed in the syllabus.

Lab Sessions: During Part 1, the SPSS computer lab will be available (without a life guard present) but no sessions are currently scheduled. You are urged to use the lab time to meet with your study group and/or complete your weekly assignments.

Note: The October 19 lab time slot will be used to launch the second phase of this course. (The session will meet at the Rome Hall lab if the usual classroom is unavailable.)

Part 2: Additional Information (Carrigan)

Class Web Site: All Part 2 course information including class notes, additional readings, and homework assignments will be posted on the course Blackboard site.

Office Hours: To sign up for office hours, please visit https://christophercarrigan.youcanbook.me/. Signing up for an available time slot will ensure that you will not need to share that time with another student.

Textbook: If you opt to use another edition of Healey’s Statistics besides the 9th, be sure you are covering the same material when reading and answering the correct assigned problems.

SPSS: SPSS is the statistical software used in the course. In addition to Rome Hall where lab sessions will take place, SPSS is available in the computer labs at Gelman Library and the Hall of Government. While it is widely used, some more advanced statistics courses at GW (including PPPA 6013) utilize other leading packages to allow you to gain experience with a variety of statistical software. You should not feel that you need to purchase SPSS, but if you do decide you want a copy, it is available at the bookstore.

Lab Sessions: During scheduled labs, the class TA, Amanda Roache, will hold her regular office hours and provide SPSS assistance to help you with assignments. Attendance is encouraged but not mandatory.

Homework Assignments: Part 2 homework assignments will be graded on a check-plus, check, and check-minus system. Feel free to work with classmates on these assignments. If you do decide to work with other students, please still turn in your own solutions and list the names of those individuals on your homework. Responses should be submitted via Blackboard prior to the start of class. For specific homework questions, the course TA, Amanda Roache, is likely your best initial source for assistance.

Final Report: This paper provides an opportunity to demonstrate your skill in analyzing data by generating relevant statistics and interpreting them using a dataset of your choice.

Part 2 Examination (December 14): The exam will not be cumulative. Rather, it will draw exclusively from material covered in Part 2. Other details regarding the final exam format will be provided closer to the date.
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<tr>
<th>Session</th>
<th>6002 Session Topics</th>
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<tr>
<td>Week 1: Aug 31</td>
<td>Field trends; Research questions; Literature review; Research ethics</td>
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<tr>
<td>Week 2: Sept 7</td>
<td>Question and questionnaire design; Survey sampling systems</td>
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<td>Week 3: Sept 14</td>
<td>Mail, telephone, and e-mail surveys; Measurement validation</td>
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<td>Week 4: Sept 21</td>
<td>Causal inference and RCT designs</td>
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<td>Week 5: Sept 28</td>
<td>NEC group designs; Time series and correlational designs</td>
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<td>✓</td>
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<td>Week 6: Oct 5</td>
<td>Qualitative research; Focus groups</td>
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<td>Week 7: Oct 12</td>
<td>Univariate descriptive statistics and analysis of crosstabulations</td>
<td>Review for exam</td>
<td>✓</td>
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<td>Week 8: Oct 19</td>
<td>Examination (Conclusion of Part 1)</td>
<td>Part 2: Sampling distribution (First session may be at Rome 104B)</td>
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<td>Week 9: Oct 26</td>
<td>Estimation and confidence intervals</td>
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<td>✓</td>
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<td>Week 10: Nov 2</td>
<td>Hypothesis testing; Difference of means</td>
<td>✓</td>
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<td>Week 11: Nov 9</td>
<td>Contingency tables; Chi square test of independence</td>
<td>✓</td>
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<td>Week 12: Nov 16</td>
<td>Bivariate regression and correlation</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Week 13: Nov 30</td>
<td>Multiple regression</td>
<td>✓</td>
<td>✓</td>
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<td>Week 14: Dec 7</td>
<td>Partial tables analysis</td>
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<td>Week 15: Dec 14</td>
<td>Examination (Conclusion of Part 2)</td>
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Introduction to 6002, plus:
trends in methods; research questions and hypotheses; literature review; meta-analyses; research ethics

Readings:
- Links at class web site
- Patten, topics 12-23 (Note “topics” not pages)
- Adams, “Using the Internet” (Blackboard)

Broad 20th century research trends
“Traditionalism”
Behavioralism / basic research
Classic model of scientific research steps
Theory; Hypothesis
Independent variable (X); Dependent variable (Y)
Operationalize concepts; operational definition

Applied research / policy analysis
Model of applied research steps

Basic structure of the written research report:
Intro; lit review; methodology; findings; discussion

Main goals of literature review
Some tips for upgrading the literature review

Meta-analysis purpose and strengths
Steps in conducting a meta-analysis

Principles of research ethics
Institutional Review Board (IRB)
Informed consent
Issues with coercion, privacy, confidentiality, risks, deception, common courtesy, debriefing, and vulnerable populations

Survey Research and Measurement Validity and Reliability

Readings:
- Links at class web site
- Patten, session 2: topics 24-30
- Patten, session 3: topics 7-8, 31-33, 35, 49

Principles for designing good individual questions
Ways to filter or minimize “random responses”
Best practices for overall questionnaire flow:
- Short intro; easy start; broader to more detailed; sensitive questions later; demographics at end
Closed-ended vs. open-ended questions
Likert item (strongly agree/agree/disagree/strongly disagree)

Census vs. sample
Random vs. nonrandom samples
Nonrandom (nonprobability) sampling such as convenience, snowball, and purposive sampling
Simple random sampling
Systematic random sampling
Stratified random sampling
(Proportionate vs. nonproportionate)
Probability-proportional-to-size (PPS) sampling
Sampling frame (source/list used to draw sample)

Nonresponse bias vs. response bias
Evaluating response rates; how high is high enough?
Factors for the optimum size of a completed sample

Survey participation as a quick cost-benefit decision
Best practices for improving survey response rates
Benchmark confidence intervals (95% level) for
n=100 (±10%); 600 (±4%); 1100 (±3%)

Operationalize; operational definition
Measurement reliability & measurement validity
Subjective validity: face validity & content validity
Criterion validity: concurrent & predictive validity

Measurement levels: nominal, ordinal, interval, ratio
Combined interval and ratio = scale or interval

Categorical vs. continuous variable
Unobtrusive measures; multiple measures
4 Causal Inference and RCT Designs

Readings:
• Links at class web site and Blackboard
• Patten, topics 2, 41-44, 46

Three elements of causal inference...
1) X & Y covary; association; concomitant variation
2) X before Y; direction; time sequence; temporal order
3) Rule out Zs; no plausible alternative; nonspuriousness

Antecedent variables
Intervening variables

Campbell & Stanley’s design diagraming system
Single group posttest only
Single group pretest-posttest (aka before-and-after)
Static group design (nonequivalent comparison design)

Threats to internal validity (partial list):
  History
  Maturation
  Practice
  Instrumentation
  Regression to the mean
  Selection
  Intragroup history
  Attrition/Mortality (and how to deal with attrition)

Randomized, controlled trial (RCT) = true experiment

Elements of a true experiment (RCT):
  (1) random assignment of subjects from pool to groups and (2) random assignment of X to groups

Reason for the power of experimental designs:
  Comparability of the groups (i.e., only real difference between the groups is X, so X is the best explanation for differences in the groups)

Classic experimental design
  (aka pretest-posttest control-group design)

Posttest only experiment
  (aka posttest-only control-group design)

Factorial designs (simple or complex)
Dosage/sensitivity designs
Complex X
Multiple Ys

RCT’s two essential elements

External validity (generalizability)
Random assignment from pool of subjects to groups
  strengthens internal validity.
Random selection from the relevant population
  strengthens external validity.

Reactivity
Hawthorne effects
Placebo
Watch out for between-group reactivity as well as other types of reactivity (e.g., with X and staff)

Big four sets of validity issues:
  Construct (measurement) validity
  Internal validity
  Statistical conclusion validity
  External validity

5 NEC, Time Series, Correlational Designs

Readings: • Links at class web site and Blackboard
• Patten, topics 3-4

Practical reasons why RCTs may not be conducted
Quasi-experiments (vague term)
Causal-comparative designs
Nonequivalent comparison group (NEC) designs
Pretest-posttest nonequivalent comparison design
Posttest only nonequivalent comparison group design

Key threat to internal validity of NEC designs:
  selection
Retrospective matching design (ex post facto
  with nonrandom posttreatment matching)
Causal-comparative (another term for studies that try to infer causality with groups not randomly assigned)
Natural experiments (strict vs. broad usage of term)

Time series (aka longitudinal) research
Simple interrupted time series
Reiterative time series
Multiple time series
Panel data (aka "panel-back") vs. cross-sectional data
Deceptive time series charts (truncated base)
Retrospective pretests; proxy pretests
Fallacy of time series inferences from a single survey
Process and logic of correlational designs

Correlational design problems:
Selection threats motivation and self-selection, plus difficulty in statistically controlling all Zs; specification error / omitted variable bias; so findings may vary widely depending on the availability and choice of control variables

Ecological fallacy
Aggregate data (units of analysis are groups)

Overall assessment of causal designs:
Lab experiments: often strong on internal validity but weak on external validity
Nonexperimental field studies: often strong on external validity but weak internal validity

Field experiments: strong in both internal and external validity but often not feasible to conduct
The logic of inferring causality by coupling lab experiments with nonexperimental field studies

Checklist for conducting and evaluating research

Qualitative Research
More exploratory than hypothesis testing
Small, purposive sample, not large random
Extended, intense observations or interviews
Unstructured or semi-structured data gathering
Essay reports with little or no quantitative data
Often explore the researchers’ subjective impact

Focus groups purposes:
Probing attitudes, reaction testing, brainstorming
Focus group: participant recruitment; focus group size; session length and agenda; moderator style; and ideal focus group facilities

Content analysis
Inter-coder reliability testing
Content analysis steps:
Define scope; Operationalize variables to code
Refine and test coding system;
Code content; Analyze data

Univariate Descriptive Statistics and Interpretation of Crosstabulations
Readings:
• Links at class web site and Blackboard
• Patten, topics 49-50, 53-56

Good data analysis requires good data, plus awareness that: all summary statistics are reductionist, context dictates interpretation, small differences should not be exaggerated, correlation does not prove causation, start with univariate analysis before multivariate.

Nominal univariate statistics – percent and mode
Interpretation pitfalls include:
Misleading pictograms; confusing absolute and relative percent; misinterpreting mode as midpoint; and misleading modal composites

Plurality vs. majority

Measures of central tendency:
mean and median, plus trimmed mean
Mode (not necessarily a central tendency)
Measures of dispersion:
- standard deviation and interquartile range
- Positive skew (high values pull mean above median)
- Negative skew (low values pull mean below median)

Normal curve
- ± 1 standard deviation = 68.3% of normal curve
- ± 2 standard deviations = 95.4% of normal curve
- ± 3 standard deviations = 99.7% of normal curve

Value of examining frequency distribution charts
- Descriptive vs. inferential statistics
- Confidence intervals, sampling error, margin of error

Standard error of the mean (formula optional)
- Standard error of the proportion (and formula)
- Central limit theorem

Boxplots, stem-and-leaf plots
- Histograms, bar charts, pie charts

Interpreting crosstabulations (aka: crosstabs or contingency tables) using counts, row percent, column percent, total percent, and marginal

Lab session: Review for examination over Part 1

9 Estimation and Confidence Intervals
Readings:
- Healey, Chapter 7

Two types of estimates, point and interval
- Estimator (used to estimate the population parameter by approximating it).
- Good estimators are 1) unbiased and 2) efficient

Formula to construct confidence interval around a sample mean when do not know σ:
\[ c.i. = \bar{X} \pm Z \left( \frac{s}{\sqrt{n}} \right) \]
where Z is the critical value

Consider alpha (α), which is the probability that the interval does not contain population parameter, and confidence level \( (1 - \alpha) \) to determine critical value

Adjust interval through n and confidence level

Formula to construct a confidence interval around a sample proportion:
\[ c.i. = P_s \pm Z \sqrt{\frac{P_s(1-P_s)}{n}} \]
where \( P_s \) is the sample proportion

10 Hypothesis Testing; Difference of Means
Readings: • Healey, Chapters 8 and 9

One and two sample hypothesis tests

Hypothesis testing steps:
\[
\begin{align*}
1. & \text{ State assumptions} \\
2. & \text{ State null (H}_0\text{) and alternative/research hypotheses (H}_A\text{)} \\
3. & \text{ Select critical value} \\
4. & \text{ Compute test statistic} \\
5. & \text{ Compare test statistic to critical value.} \\
   & \text{ Decide whether to reject or fail to reject } H_0
\end{align*}
\]

Null hypothesis is a statement of no difference, specified in terms of populations. The null is the assumption, but it is never “proven.” Failure to detect a relationship, especially in a small sample, does not mean there is no relationship.
Z (critical) = ±1.96 if want to be 95% confident, associated with \( \alpha = 0.05 \)

Formula to compute the test statistic for a one-sample means test when do not know \( \sigma \), and sample is sufficiently large (\( n \geq 30 \)):

\[
Z(\text{obtained}) = \frac{\bar{X} - \mu}{s / \sqrt{n}}
\]

Formula to compute the test statistic for a one-sample proportions test (where \( P_u \) is the population proportion):

\[
Z(\text{obtained}) = \frac{P_s - P_u}{\sigma_p} = \frac{(P_s - P_u)}{\sqrt{P_u(1 - P_u) / n}}
\]

Formula to compute the test statistic for a two-sample means test when \( n_1 \geq 30 \) and \( n_2 \geq 30 \):

\[
Z(\text{obtained}) = \frac{\bar{X}_1 - \bar{X}_2}{\sigma_{\bar{X}_1 - \bar{X}_2}} = \frac{(\bar{X}_1 - \bar{X}_2) / \sigma_{\bar{X}_1 - \bar{X}_2}}{\sqrt{s_1^2 / n_1 + s_2^2 / n_2}}
\]

Formula to compute the test statistic for a two-sample proportions test (where \( P_u = \frac{n_1P_{s1} + n_2P_{s2}}{n_1 + n_2} \)):

\[
Z(\text{obtained}) = \frac{(P_{s1} - P_{s2})}{\sqrt{P_u(1 - P_u) / n_1 + n_2}}
\]

Student’s t distribution replaces Z distribution where df (degrees of freedom) is \( n - 1 \) when \( n < 30 \) since \( s \) is no longer a good estimator of \( \sigma \). As \( n \) increases, t distribution converges to Z distribution.

1. **Tradeoffs in testing:**
   1. Type I v. type II error. Lowering \( \alpha \) reduces type I error (reject true null) but increases type II error (fail to reject false null)
   2. Statistical v. substantive significance. Large samples can show statistical significance for trivial relationships
   3. One v. two-tailed tests. A one-tailed test increases the likelihood of rejecting the null by lowering Z(critical) but only if theory supports it

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### 11 Contingency Tables; Chi Square Test of Independence

**Readings:**
- *Healey, Chapters 11 and 12 (through p. 317)*

When both variables are nominal or ordinal, create a “contingency” table (independent variable in the columns and compute “conditional” percentages

Maximum percentage-point difference in conditional percentages represents the relationship magnitude

Rough cutoffs for the relationship strength:
- 0-10 %-points (weak); >10-30 %-points (moderate); >30-100 %-points (strong)

Chi square (\( \chi^2 \)) distribution with \( v \) degrees of freedom (df) is the sum of \( v \) squared independent standard normal random variables (\( Z_1^2 + Z_2^2 + \cdots \))

Degrees of freedom for \( \chi^2 \) (critical) = \( (r-1)(c-1) \) where
- \( r \) is the number of rows and \( c \) is the number of columns in the contingency table

Formula to compute the chi square test for independence:

\[
\chi^2(\text{obtained}) = \sum \frac{(f_o - f_e)^2}{f_e}
\]

where \( f_o = \) observed cell frequencies and \( f_e = \) cell frequencies that would be expected if the variables are independent

Formula to determine expected frequencies:

\[
f_e = \frac{\text{row marginal} \times \text{column marginal}}{n}
\]

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### 12 Bivariate Regression and Correlation

**Readings:**
- *Healey, Chapter 14*

Scatterplot (positive, negative, or no relationship)

Formula for bivariate regression:

\[
\hat{Y} = a + bX
\]

where \( \hat{Y} = \) predicted value for dependent variable (\( Y \) on the regression line), \( b = \) slope, and \( a = \) intercept

Regression gives the formula for the straight line that comes closest to the conditional means (average \( Y \)’s for observations with the same \( X \) value)
Slope represents the “magnitude.” The amount of change in Y when X increases by 1 unit

Residuals represent the difference between actual and predicted values (\(Y_i - \hat{Y}_i\))

Regression assumes the relationship is linear. Not appropriate for curvilinear patterns unless the specification of the variables is altered

Formula to compute the test statistic for the hypothesis test to determine whether there is a relationship between X and Y in the population (H0: \(\beta = 0\) where \(\beta = \) population slope coefficient) is:

\[t(\text{obtained}) = \frac{b - 0}{SE(b)}\]

where \(SE(b)\) is the standard error of the slope

Correlation coefficient (r) ranges from -1 to 1 and measures the strength of the relationship. No linear relationship when \(r = 0\)

Rough cutoffs for the strength: -0.3 \(\leq r \leq 0.3\) (weak); -0.6 \(\leq r < -0.3\) or 0.3 \(< r \leq 0.6\) (moderate); \(r < -0.6\) or \(r > 0.6\) (strong)

Null hypothesis in test of statistical significance of r is \(\rho = 0\) where \(\rho = \) population correlation coefficient

### Multiple Regression

**Readings:**
- Healey, Chapter 16

Formula for multiple regression:

\[\hat{Y} = a + b_1X_1 + b_2X_2 + \ldots + b_nX_n\]

where e.g., \(b_1\) = partial slope of the linear relationship between \(X_1\) and \(Y\)

Each slope shows the amount of change in \(Y\) when that independent variable increases by 1 unit:
- holding the other independent variables constant
- controlling for the effects of the other independent variables

Coefficient of determination (\(R^2\)) measures the proportion of the variation in \(Y\) that can be explained by the regression

Limitations of \(R^2\) even when its value is high:
1. Always increases when add variables (except in the rare case where the additional variable has absolutely no effect)
2. Does not indicate which variables are significant
3. Does not mean that important variables have not been omitted

Adjusted \(R^2\) does not necessarily increase when a variable is added to the regression

Dummy (indicator) variables take the values 0 and 1. Used when nominal or ordinal independent variables are included in the regression

To avoid perfect multicollinearity, add one fewer dummies than the number of categories in the nominal/ordinal variable

Intercept is the predicted value for the omitted category and slope coefficients are interpreted relative to the omitted category

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### Partial Tables Analysis

**Readings:**
- Healey, Chapter 15 (except pp. 418-420)

Partial tables analysis signifies examining the relationship between \(X\) and \(Y\) for each category of \(Z\).

Introducing \(Z\) can affect the understanding of the relationship between \(X\) and \(Y\) in various ways. Relationship can be:
1. Direct (\(Z\) does not alter \(X-Y\) relationship)
2. Spurious (\(Z\) is the cause of the \(X-Y\) relationship)
3. Intervening (\(Z\) is the link between \(X\) and \(Y\))
4. Suppressor (absence of \(Z\) is masking \(X-Y\) relationship)
5. Interacting (\(X-Y\) relationship changes across categories of \(Z\))

Lab session: Review for Part 2 examination

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### Examination for Part 2
PPPA 6002. Research Methods and Applied Statistics

Development of skills and knowledge for conducting original research and critically evaluating empirical studies. Various research designs and data collection techniques are examined. Focus on computerizing data sets for quantitative analysis, analyzing strength of relationships, selecting appropriate statistical techniques, and testing statistical hypotheses.