ED/EPSY 503 Essentials of Quantitative Inquiry in Education  
Fall Semester 2021. Class time: Thursdays, 5 - 8 PM.  
(Semester: August 23, 2021 through December 3, 2021. Final exam week: December 6-10).

Instructor: George Karabatsos  
Email: georgek@uic.edu  
Office: 1034 ETMSW  
Office Hours: Thursday 2-5 PM  
Please e-mail before meeting me during office hours  
Classrooms: Blackboard collaborate  
BSB 215  

TA:  
Email:  
Office: Office Hours:  

Computer Lab: 2027 ETMSW (ETL)

Course Description: This entry level course in statistics covers classical descriptive and inferential statistical methods which address a range of common applied research problems. These methods are corresponded with some underlying statistical theory. The course primarily illustrates these methods through the analysis of real data sets using statistical software packages.

Textbooks (purchase not required)  

These are reader-friendly, intermediate level statistics textbooks which cover topics ranging from introductory statistics, hypothesis tests (e.g., t-tests, chi-square test, nonparametric tests), correlation, ANOVA, linear regression, logistic regression, power analysis, and more. The first book covers basic statistical methods. The second book provides a step-by-step guide on how to use the SPSS statistics software. The King et al. textbook should be read on a weekly basis, to help you attain a more detailed understanding about the contents covered in this course. However, these textbooks are not required to complete the course assignments and exams.

Technology: SPSS Statistical Package: Version 15 or higher, available in ETL  
*I strongly recommend that you install, purchase, and use SPSS on your own personal laptop or desktop computer, which you can use to complete most course assignments and during the lectures. SPSS software can be searched, purchased, and downloaded from https://webstore.illinois.edu/home/ The R software package (https://www.r-project.org/) can be installed free of charge, to conduct power analysis using the pwr package: https://cran.r-project.org/web/packages/pwr/index.html or Multiple Hypothesis Testing with False Discovery Rate (FDR) control. It is possible for you to use other statistical software packages for this course, if you wish.

Course Outcomes  
• Students can recognize and define the basic concepts of descriptive and inferential statistics.  
• Students can arrive at reasonable accurate answers to selected statistical problems.  
• Students can demonstrate competence in using SPSS for data analysis.  
• Students can recognize when and when not to use certain statistical procedures.  
• Students can apply statistical procedures to data to answer research questions.
Course Requirements

Homework Assignments: Students will receive 8 homework assignments. The homework assignments have two primary aims:
(1) to reinforce your statistical learning;
(2) to assess your on-going learning, which in turn will help guide my instruction of the course.

Scoring: There are 8 homework assignments in total, each worth a maximum of 50 points. The 8 homework assignments are together worth 40% of the final grade.

Quizzes: There are 4 take-home, open-book quizzes, worth 50 points each. The 4 Quizzes are together worth 20% of the final grade.

Exams: The course has a Midterm Exam, and a Final Exam, covering problems like those found in the homework problems or quizzes. Each is an open-book take-home exam, which should be completed by the stated due date. The midterm (worth 200 points) focuses on the content of the first half of the course. The final exam (worth 200 points) focuses on the entire course content.

Each assignment (Homework, Quiz or Exam) assignment is due by 11:59 pm in the stated due date, after the lecture day. Students should submit their homework through blackboard by clicking the “HW” link. The Teaching Assistant (TA) or instructor will grade and give feedback on the homework assignments via blackboard before each week of class. Please contact the TA (or instructor) via email or face-to-face about any questions related to homework assignments and quizzes.

For each assignment, if you are not satisfied with the grade score that you received on your first attempt on the assignment, then you can submit a revised version of your assignment in an attempt to achieve a better score. Submissions of revised assignments are due within 1 week of the original due date of the assignment. Whenever you do submit a revised assignment, please write an extra paragraph that explains what you changed from your first attempt and what the changes mean, and indicate the changes and revisions using red font and/or yellow highlight. (For example, if you had reported the wrong sample average, then report it correctly in a new write-up and then tell me what that number refers to/tells the reader about the analysis or results).

Any assignment that is submitted within one week late is worth a maximum of 70% of its total possible score (40 points for Homework; 50 points for Quiz; 200 points for Midterm), and any submission of a revised version of a late assignment is due within the same week as the original assignment due date. Any missing assignment, or assignment submitted 1 week past its original due date, will receive a 0 score. In contrast, the Final exam has absolute due dates for the original submission and for the revision submission, which are stated later in this syllabus.

Grading: The final course letter grade will be based on all 8 homework assignments (400 points total), 2 quizzes (200 points total), midterm exam (200 points), and final exam (200 points). The final letter grade of the course will be assigned according to the following grading scale:

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*The instructor reserves the right to make any changes in the course he determines academically advisable. Changes will be announced in class. It is your responsibility to keep up with any changed policies.*
Course Topics and Objectives

Introductory Concepts
• Distinguish between a population and a sample.
• Distinguish between a parameter and a statistic.
• Distinguish between the purposes of descriptive statistics and inferential statistics.
• Describe the methods, benefits, and limitations of probability sampling strategies.
• Distinguish between independent, dependent, constant, and intervening variables.
• Understand and contrast nominal, ordinal, interval, and ratio scales of measurement.
• Describe threats to internal and external validity and ways to control them in research designs.
• Know pre-experimental, experimental, quasi-experimental, and ex post facto research designs.

Frequency Distributions
• Construct a distribution of class intervals from a given data set.
• Determine the midpoint, upper class limit, and lower-class limit of a given class interval.
• Calculate a specified proportion and percentage from a given data set.
• Understand and contrast histograms, bar graphs, frequency polygons, and stem and leaf plots.
• Construct a frequency table from a given data set.
• Construct a histogram, bar graph, frequency polygon, stem and leaf plot, and frequency ogive.
• Describe the symmetry of a distribution or data set.
• Understand and contrast a leptokurtic, mesokurtic, or platykurtic distribution, of data.
• Construct a grouped frequency distribution from a given data set.
• Interpret the practical significance of a given frequency distribution.

Central Tendency and Variability
• Understand and contrast measures of central tendency.
• Calculate the mean, median, and mode of a given data set.
• Explain the meaning of a multi-modal distribution.
• Determine the impact of changing values in data on the mean of the mean, median, and mode.
• Describe how measures of central tendency and dispersion complement one another.
• Understand and contrast different measures of dispersion.
• Calculate the variance, and standard deviation, range, and interquartile range of data.
• Explain the mean and standard deviation, for a sample, and for a population.
• Understand the degrees of freedom.
• Know the most appropriate measure of central tendency and dispersion, for a given data set.

Normal Curve and Inferential Statistics
• Describe the properties of the normal distribution.
• Compare two scores from given distributions and interpret the results.
• Explain the purpose of using standardized scores.
• Convert raw scores to standardized scores and vice versa based on a given set of data.
• Explain the practical significance of a standardized distribution.
• Determine the proportion of scores within a given standard deviation in a distribution.
• Understand and contrast percentile ranks and percentiles.
• Interpret a percentile based on a raw score and normal distribution.
• Explain the relationship between probability and inferential statistics.
Hypothesis Testing, Error, and Power

- Explain what a sampling distribution represents.
- Explain how the sampling distribution of the mean relates to population parameters.
- Explain the implications of the central limit theorem for research design.
- Explain the relationship between standard error, standard deviation, and population variance.
- Explain the implications of standard error for research design and interpretation of scores.
- Find the probability of obtaining a data value in a score range, for a given distribution.
- Formulate a null, alternative, directional, and non-directional hypothesis for a specified test.
- Explain the relationship between probability and hypothesis testing.
- Understand Type I and Type II error in hypothesis testing.
- Test a statistical hypothesis, and then interpret the results.
- Decide whether a one- or two-tailed hypothesis test is more appropriate for a research question.
- Explain the practical significance of statistical power.
- Know alpha level, power, and Type I and Type II error for research design, hypothesis testing.
- Explain the relationship between statistical power and effect size.

T-tests

- Describe the differences between an independent-samples t-test and a dependent-sample t-test.
- Conduct a t-test to compare means across two groups, and then interpret the results.
- Apply and interpret the results of a t-test to compare the means of two independent samples.
- Explain the assumptions of an independent-samples t-test.
- Conduct a t-test to compare means across two dependent (paired) samples, and then interpret the results.
- Explain the assumptions that should be checked when conducting a dependent-samples t-test.
- Perform power analysis for the independent-samples t-test.
- Perform power analysis for the paired-samples t-test.
- Use nonparametric tests which avoid the normality assumptions of t-tests, including the Mann-Whitney test for independent samples, and the Wilcoxon signed-ranks tests for paired samples.

ANOVA

- Determine whether a t-test or ANOVA is more appropriate for a given situation.
- Identify the levels and variables used in an ANOVA.
- Understand test-wise and experiment-wise error.
- Conduct an ANOVA to compare the means across two or more groups, and then interpret the results.
- Understand between-groups and within-groups variance.
- Describe the characteristics of the F distribution.
- Explain the assumptions that should be checked when conducting a dependent-samples t-test.
- Explain the considerations for sample size when conducting an ANOVA.
- Calculated the values needed to construct an ANOVA summary table.
- Explain the purpose and considerations for conducting post hoc ANOVA comparisons.
- Calculate the effect size for an ANOVA, and then interpret the results.
- Perform power analysis for the ANOVA F test.
- Use nonparametric tests which avoid the normality assumptions of ANOVA, including the Kruskal-Wallis one-way ANOVA.
**Correlation**
- Explain the purpose of correlation testing, based on Pearson’s $r$ correlation coefficient.
- Describe the relationship between two variables based on their distribution.
- Calculate Pearson’s correlation coefficient for a given data set.
- Understand the assumptions that should of the Pearson’s correlation coefficient.
- Explain the difference between correlation and causation.
- Describe how restricted ranges and outliers affect correlation coefficients.
- Understand and interpret the coefficient of determination.
- Calculate Pearson’s correlation coefficient for a given correlation coefficient or data set.
- Conduct a correlation test, and then interpret the results.
- Perform power analysis for the correlation test.
- Use nonparametric tests which circumvent the normality assumptions of the test based on Pearson’s $r$ correlation coefficient, including the test based on Spearman’s rho rank-order correlation, and the test based on Kendall’s tau rank order correlation.

**Regression**
- Describe the relationship between correlation analyses and linear regression analyses.
- Determine the equation for the regression line for a given data set or correlation coefficient.
- Conduct a regression test, and then interpret the results.
- Explain what a standard error of the estimate means in terms of regression.
- Determine the proportion of variance accounted for by a set of variables.
- Understand the key assumptions of linear regression.
- Perform power analysis for linear regression, in the test of significant predictor variable(s).
- Understand how to conduct a logistic regression for binary (discrete) dependent variables.

**Chi-Square**
- Understand parametric and nonparametric statistical tests.
- Explain the purpose of one-way and two-way chi square tests.
- Conduct a chi square goodness-of-fit test, and then interpret the results.
- Perform power analysis for a chi-square test.
**Special Needs**
UIC strives to ensure the accessibility of programs, classes, and services to students with disabilities. Reasonable accommodations can be arranged for students with various types of disabilities, such as documented learning disabilities, vision, or hearing impairments, and emotional or physical disabilities. If you need accommodations for this class, please let me know your needs, and I will help you obtain the assistance you need in conjunction with the Office of Disability Services (1190 SSB, 312-413-2183).

**Academic Honesty**
Some students are clearer than others on the norms of academic integrity, including what counts as plagiarism. A useful treatment of forms of academic dishonesty, including plagiarism, can be found at [http://www.uic.edu/depts/sja/integrit.htm](http://www.uic.edu/depts/sja/integrit.htm) (see #3 & #7, specifically). Please familiarize yourself with the forms of academic dishonesty as recognized by the University. If you have any questions about whether a specific activity constitutes academic dishonesty, you can ask me, or contact UIC administrator Belia Gonzalez McDonald, beliag@uic.edu or 312-996-4857.

**Importantly, let’s all have fun in this course while learning and talking about statistics.**
The instructor welcomes input, suggestions, and feedback throughout the semester from students.