WINONA STATE UNIVERSITY

COLLEGE OF SCIENCE AND ENGINEERING

DEPARTMENT OF MATHEMATICS AND STATISTICS

**Course Outline – STAT 335**

**Title:** Principles of Study Design

**Number of Credits:** 3

**Catalog Description:** This course will provide an introduction to study design and proper methods of data collection. Students will gain an overview of the research cycle, basic principles of experimental design, observational studies, effective design of survey instruments, examples of study bias, and ethical considerations in the conduct of research. Offered yearly.

**Possible Textbooks:**

* Bethlehem, Jelke. (2009). Applied Survey Methods: A Statistical Perspective. Wiley, ISBN: 978-0-470-37308-8.
* Committee on Professional Ethics. (1999). Ethical Guidelines for Statistical Practice. Online: [www.amstat.org/committees/ethics/](http://www.amstat.org/committees/ethics/)
* Cortina, Jose M. (1993). What is Coefficient Alpha? An Examination of Theory and Applications. Journal of Applied Psychology, Vol. 78, N.o 1, 98-104.
* Lohr, Sharon L. (1999). Sampling: Design and Analysis. Duxbury (Cengage Learning), ISBN-10: 053435614
* Thayer-Hart, Nancy et al., (2010). Survey Fundamentals. Online: <http://oqi.wisc.edu/resourcelibrary/uploads/resources/Survey_Guide.pdf>

**Topics Covered:**

1. Research Cycle
   1. Formulating a research question
   2. Variables (Qualitative and Quantitative)
   3. Design of study
   4. Data collection
   5. Descriptive analysis
   6. Inferential analysis
   7. Drawing conclusions
      * Actionable outcomes
      * Policy development
      * Future research
2. Types of Studies
   1. Designed Experiments
   2. Observational Studies
   3. Surveys
3. Design of Experiments
   1. Basic definitions (factors, treatments, experimental units)
   2. Confounding variables
   3. Fundamental design concepts: control, randomization, replication
   4. Placebos
   5. Single- and double-blind experiments
   6. Completely randomized designs
   7. Randomized block designs
   8. Cross-over studies
   9. Longitudinal studies
4. Observational Studies
   1. Descriptive vs. analytic studies
   2. Types of observational studies
      * Prospective
      * Retrospective
      * Cross-sectional
   3. Effects of confounding variables
   4. Matching methods
5. Surveys
   1. Sampling Methods
      * Probability sampling (simple random sampling, stratified sampling, cluster sampling, multi-stage sampling)
      * Non-probability sampling (convenience sampling, purposive sampling, quota sampling)
      * Comparison of sampling error estimates for different sampling methods
      * Oversampling
   2. Questionnaire Design
      * Open- vs. closed-ended questions
      * Rating questions (e.g., Likert scale, visual analogue scale)
      * Ranking questions
      * “Select all that apply” questions
      * Wording of individual questions
      * Ordering of questions
   3. Reliability
      * Test-retest reliability (Pearson’s correlation, inter-class correlation coefficient, kappa coefficient)
      * Parallel forms reliability
      * Internal Consistency (inter-item correlations, split-half reliability, Cronbach’s alpha)
   4. Validity
      * Face validity
      * Content validity
      * Criterion-related validity (predictive, concurrent, convergent, discriminant)
   5. Types of bias
      * Non-response bias
      * Coverage bias
      * Self-selection/volunteer bias
      * Social desirability bias (can discuss the randomized response survey technique)
      * Interviewer effects
      * Errors in transfer of findings
      * Survey format effects (e.g., wording/ordering of questions)
6. Ethical Considerations in the Design of Studies
   1. Ethical treatment of research subjects
      * Belmont report/ Nuremberg code
      * Institutional Review Boards
      * Clinical trial considerations
   2. Responsibility to apply sampling and analysis procedures scientifically, without pre-determining the outcome
7. Responsibility to clearly report the intent of a study, how it was performed, and any limitations on its validity

**Listing of Sections to be Covered:** Not applicable to this course, since there is no standard textbook. Chosen sections of any text should correspond to the topics outlined above.

**Remarks:** None.

**Approximate Pace of Coverage:** Not Applicable.

**Method of Instruction:** Methods may include lecture, case studies, discussion, and group work.

**Evaluation Procedure:** Assessments will vary in style and may include written exams, quizzes, homework assignments, written reflections of relevant readings, and group projects.

**Minnesota Transfer Curriculum:** None

**MnSCU Learning Outcomes:**

* This course will promote a student’s ability to correctly design an experiment applying the concepts of control, replication and randomization. A successful student will be able to decide what type of design is appropriate for a given study. In addition, a successful student will be able to develop a well-designed experiment to address industrial problems.
* This course will promote a student’s ability to recognize the strengths and weaknesses of research designs used in research studies.
* This course will promote a student’s ability to correctly design and implement a research study. A successful student will be able to design an ethical and valid study to evaluate a hypothesis of interest.
* This course will promote a student’s ability to report and communicate conclusions effectively. A successful student will be able to communicate essential features and results of a research study in a manner which is understandable to both technical and non-technical audiences.
* This course will promote a student’s ability to recognize and reflect critically on ethical issues commonly encountered in research studies.
* This course will promote a student’s ability to use appropriate technology to describe and analyze data from research studies. A successful student will be able to use statistical software packages to perform analyses and interpret the results from the given output.

**Possible Computer Software:**

* JMP
* R

**Last Revised:** Spring 2015 by the Statistics Subgroup.