



Experimental Design & Statistics (CLFS 725)

“Someone once said that all children are born with the spirit of research, but that it is spanked out of most by the age of seven. While this conclusion may be an overstatement, we must admit that the spirit of research does suffer a bit during the early years from such things as parental fears, methods of teaching, and demands for conformity. But the spirit often becomes only latent, and like Sleeping Beauty in the fable, is ready to be awakened by the right kiss of circumstance.”
James Westman (1961) *Why Fish Bite and Why They Don’t*. Prologue: pp. 3-4.

Overview

CLFS 725 is a two-credit graduate course that focuses on helping participants develop the skills necessary to plan, conduct and analyze original experiments. The course is designed for teachers developing new innovative laboratories for their students, or participating in research projects with other investigators. Unlike traditional laboratory courses which focus on the laboratory and field techniques for collecting data, this course emphasizes the development of effective experimental designs. Participants completing this course will be expected to design innovative research projects for their own students that will be presented to the other class members.

All of the laboratory exercises in CLFS 725 can either be performed within the course website, or by using materials that are readily available locally. A fundamental component of the course is an experimental design package within the course website. This package consists of a hyperlinked, decision tool that uses information provided by an investigator to identify appropriate experimental designs and analytical tools for a particular study. Further, the design tool is linked to conceptual overviews and customized spreadsheets of specific statistical tests and

recommendations of the appropriate forms of tables and graphs to use with different experimental designs.

The course is based on a cooperative learning model, with participants assigned to research groups that work together to investigate the principles of experimental design and apply these principles to research problems presented in the course. This course contains a number of components that will help research groups (and individual participants) to develop effective designs for biological experiments:

- **Readings** are used to provide the basic theory behind the experimental designs used in biological research. These readings are in the form of web-based notes and optional sections from the course textbook.
- **Laboratories** are the most critically important portion of the course. In these exercises, research groups apply the experimental design principles they have learned to specific research problems. Unlike traditional laboratories, each research group constructs, implements, and analyzes an experiment of their own design.
- **Individual portfolios** are required of each participant. Each portfolio consists of two research projects selected and designed by an individual participant in the format most appropriate for their own students.

Webtext

The course website contains an online textbook, *A Conceptual Review of Experimental Design for the Life Sciences*, which provides a compact, essentially non-mathematical overview of experimental design. The information within the webtext is sufficient to successfully complete CLFS 725.

Laboratories

The laboratory exercises for the course are available online within the course website. Each unit in the course contains one exercise. The exercises contain a problem to be investigated experimentally, accompanied by reference articles and web sites on useful experimental procedures. Exercises are available in condensed, downloadable formats for use as hard copies away from networked computers.

Grading

Laboratory Exercises

The course consists of eight units, each one week in length. There is an assignment due at the end of each unit. The assignment for each of the first seven units is a laboratory exercise. To facilitate work on these assignments, the following time table will be followed:

Monday: The new unit begins.

Wednesday: Individual experimental designs for the laboratory exercise are due.

Sunday: Group laboratory report is due.

The grade for each assignment will be based on two components: (1) the group submissions, and (2) each individual's contributions to these.

The group submissions for the laboratory exercises will be graded on a 10 point scale, with the grade determined by the overall scope and completeness of the response. Grading for individual contributions are more complicated, but is also based on 10 points:

4 points for submitting an individual response to the lab assignment. The individual responses should be electronically submitted as a Word file on the Assignment link, as well as posted to your group area. To receive all 4 points individual responses must be submitted on time (i.e., by Wednesday).

4 points for actively participating in group discussions during the completion of the final submissions for grading. Active participation will be defined as providing *two substantive suggestions* that move the discussion forward. Comments such as "I don't think this portion of the answer is clear. Perhaps we should rewrite it as ...", or "I think _____ is more important to this process and we should place greater emphasis on it." would be substantive and would clearly indicate active participation. Responses such as "Good job!" or "I completely agree." would not be considered substantive. All discussions about the final submission should be in the the groups discussion area.

2 points for work beyond the minimum necessary for completing the discussion question. For example, someone who made more than the minimum two substantive suggestions during the completion of the final answer or who performed

significant amounts of editing while writing the final submission would receive these points.

Note: If someone does the minimum work: i.e., (1) submits an individual response, (2) submits it on time, and (3) provides two substantive suggestions during the drafting of the final answer, they would receive a total of 8 points (= 80%, or a B) for the individual portion of the assignment. To receive an A for this portion of the grade, they would need to do work beyond the minimum and earn the remaining 2 points.

Group submissions to the unit lab assignments are due on Sunday and should be electronically posted to the Assignments area of the course website. Only one group member needs to post the assignment, which will automatically be attributed to all group members.

Individual Portfolios

The final units consists of individual portfolios, which are not group activities. Portfolios consist of two laboratory exercises selected by each participant and presented in a format for use with the participant's own students. They can be modifications of existing laboratories or original exercises. Each exercise will be graded on a total of 80 points:

10 points for feasibility and suitability.

15 points for correctly identifying relevant variables.

30 points for the suitability for the overall experimental design.

25 points for appropriate analysis.

Portfolios are due on Wednesday, 7 Feb.

Summary

The course grade is based on a total of 300 points, divided among the three listed activities. The total points are distributed among these activities in the following manner:

140 points	Laboratory exercises performed by research groups and posted to the course website. Laboratories are graded on a 20 point scale (= 10 points for the group response and 10 points for individual responses; see above). There is no laboratory exercise due during Unit 8.
160 points	Individual portfolios of two laboratory exercises presented in a format for use with the participant's own students. Each exercise will be graded on an 80 point scale.
300 points	TOTAL

Missed Work

Occasionally, course participants may miss a unit due to other obligations (e.g., illness, family obligations, etc.) Notify both the members of your group and the course staff of any absences. Missed work will be completed as an individual, rather than a group, assignment *within one week of returning to the course*.

Schedule

Unit	Webtext Readings	Laboratory Exercise
1	Introduction (sect. 1-1.3); Scientific Method & Experimentation (sect. 2-2.3); Conceptual Statistics (sect. 3-3.7)	Variables & Hypotheses in Experimental Design
2	Experimental Design Principles (sect. 4-4.6); Basic Experimental Designs (sect. 5-5.2.2)	Building Better Experimental Designs
3	Advanced Experimental Designs (sect. 6-6.2.2.2); Presenting the Results of Biological Research (sect. 7-7.3)	The Peculiar Peptide Investigative Committee
4	---	Blood Cell Anomalies in Spring Peeper Frogs
5	---	Iodine Value of Biodiesel Fuel Oils
6	---	Fractal Geometry of Oak Leaves
7	---	Dealer's Choice
8	---	Individual Portfolios