



MODULE: EXPERIMENTAL DESIGN

OVERVIEW

Learning Objectives

At the conclusion of this module, you will be able to:

- Interpretation: Define independent, dependent, and controlled variables.
- Interpretation: Define quantitative and qualitative data.
- Interpretation: List the steps of the scientific method. List the steps of the engineering design process.
- Analysis: Compare and contrast the scientific method with the engineering method.
- Evaluation: Explain how researchers select an appropriate experimentation method.
- Deduction: Explain how statistical tests are used to evaluate experimental results (data) and arrive at conclusions.
- Application: Given a research scenario, state a hypothesis, identify variables, and come up with an experimental plan using the engineering design method and scientific method

Checklist

Prior to meeting with mentor

- Review the associated materials.
- Apply your knowledge to design a real world experiment, considering both the Scientific Method and Engineering Design method to gather qualitative and quantitative data.

Discussion with mentor

- Review provided definitions and examples provided by your mentor
- Complete and discuss Experimental Design Example exercise. Be prepared to ask questions about how this could be applied to the research project you are working on in the lab
- Discuss and confirm your understanding with mentors the differences between Engineering Design and Scientific Method. Use the Engineering Design vs Scientific Method document as a guide for this discussion.



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- For additional practice, consider completing (on your own) another Engineering Design example, such as the one at the end of the Engineering Design vs Scientific Method document

Mentee Deliverables

- **Deliverable 1: Read Handout 1 and be able to state definitions to the standard vocabulary terms in Experimental Design.**
- **Deliverable 2: Read Handout 2 and be able to describe the difference between the Engineering Method and the Scientific Method.**
- **Deliverable 3: Bring a printed copy of your responses to the Experimental Design Activity to the next meeting.**
- **Deliverable 4: Bring a printed copy of your responses to the Five-Minute Reflection to the next meeting.**

Materials for this Module

- Handout 1: Experimental Design Definitions
- Handout 2: Engineering Design Vs. Scientific Method
- Handout 3: Experimental Design Activity
- TED Talks on Statistics:
https://www.ted.com/talks/ben_goldacre_battling_bad_science and/or
https://www.ted.com/talks/alan_smith_why_we_re_so_bad_at_statistics

Introduction to Experimental Design

An experiment is a process or study that results in the collection of data. The results of experiments are not known in advance. Usually, statistical experiments are conducted in situations in which researchers can manipulate the conditions of the experiment and can control the factors that are irrelevant to the research objectives. For example, a rental car company compares the tread wear of four brands of tires, while also controlling for the type of car, speed, road surface, weather, and driver. Experimental design is the process of planning a study to meet specified objectives. Planning an experiment properly is very important in order to ensure that the right type of data and a sufficient sample size and power are available to answer the research questions of interest as clearly and efficiently as possible.

Assignment(s) for this Module

Assignment(s)

Read Handout 1 which helps you learn the vocabulary of Experimental Design. Review the commonly used definitions needed to discuss and plan an experiment. You should be able to give a definition of each term



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when asked. **Deliverable 1: Read Handout 1 and be able to state definitions to the standard vocabulary terms in Experimental Design.**

Read Handout 2 which describes the difference between the engineering method and the scientific method. Did you realize there is a difference to approaching problems between these two professions? **Deliverable 2: Read Handout 2 and be able to describe the difference between the Engineering Method and the Scientific Method.**

Using the **Handout 3 Experimental Design Activity** document as a guide, conduct your own experimental design in a real world application, considering the differences between the Engineering Design Process and the Scientific Method. Pay attention to the different types of data you gather and how it can be analyzed. **Deliverable 3: Bring a printed copy of your responses to the Experimental Design Activity to the next meeting.**

Five-Minute Reflection

Come up with one question to discuss with your mentor (maybe a concept you are unclear on, something you found interesting, etc.)

What information did you feel was the most informative? Least?

Why are statistics important? Watch the TED Talks listed above, then list three reasons why statistics are important to research, and three reasons why statistics are important to your everyday life?

Deliverable 4: Bring a printed copy of your responses to the Five-Minute Reflection to the next meeting.