

**MSU Coastal Research & Extension Center**

**Lesson 4: Fundamentals in Logic**

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**Theme**

* Foundations of Science Literacy

**Grade Level**

* 9th – 12th

 **Class Size**

* 10-30 Students

**Length**

* 1.5 hours

**Instructional Methods**

* Lecture inside, Activity inside

**Evaluation Method**

* Discussion, Optional Homework Material

**Date Prepared / Modified:**

* August 10th, 2022

## Goal: This lesson explores fundamentals of science and experimental design: awareness of logical flow, hypothesis formation, experimental design.

## Learning Objectives:

##  Distinguish between deductive and inductive reasoning

## Formulate logical, falsifiable hypotheses

## Recognize the significance of testing null hypotheses

## Propose alternate hypotheses

## Distinguish independent and dependent variables

## Differentiate proper and improper experimental controls

## Examine research designs for common weaknesses

## Explain the burden of proof concept

## Classify prudential and evidential burdens of proof

**Mississippi College and Career-Readiness Standards:**

FSL.3A Students will apply science and engineering practices and skills to scientific investigations

 FSL.3C Students will apply scientific literacy and thinking skills to analyze scientific investigations found in various experimental designs including, but not limited to those found in sample ACT science passages.

* Aligns with FSL.3A.1, FSL.3C.3, FSL.3C.4, FSL.3C.5

**Prerequisite Instructor Knowledge:**

Scientific theory, method, and design.

**INTRODUCTION**

**Fundamentals in Logic Lesson Overview:**

* Engage with students prior to the lecture to determine their background knowledge on experimental design
* Explore and explain key concepts using provided PPT slides
* Apply understanding to complete scientific design in practice activity and worksheet
* Evaluate understanding of concepts by having students present their completed marsh plant science project

**LECTURE**

**Engage with students to gauge pre knowledge (5 min)**

1. Suppose every student has been in a disagreement. Maybe a political disagreement, maybe a miscommunication, or a difference in values. Ask students for an example of a disagreement in the historical past. (i.e. if the earth was round or flat).
2. It can be very difficult if not impossible to come to a resolution. Often emotions and credibility may be involved, and resolution may be left to “live and let live”. When debating the nature of things, you may be excited to learn there is a consensus, guidelines, we can use to find resolution.
3. You all probably have an inkling for it, but how does a “fact” become a “fact”? Ask students for examples.

**Explore and Explain Key Concepts of Scientific Design (45 min)**

1. Use provided PPT slides to explore the key concepts of this lesson. There are some demonstrative examples in the powerpoint, but it is primarily explaining ahead of time

[Scientific Design in Practice](https://docs.google.com/presentation/d/1uiKzzv59gYo05Boz_r4ov3SQ3leXqb4r6IGzXe-VTsI/edit?usp=sharing)-**\*PPT SLIDES PROVIDED\***

1. In small groups, have students think of research questions that they could ask about marsh plants (*Spartina alterniflora* or *Juncus roemerianus*) and why answering them would be relevant for marsh communities.
* Examples: How to grow these plants best? What environmental conditions do they grow best in?

1. Have students propose hypotheses, fashion them as a null hypothesis, and offer alternative hypotheses.

1. Students should fill out the accompanying worksheet: [Step 3 - Scientific Design in Practice Student Sheet](https://docs.google.com/document/d/1D7e0JHAelmnbzmDM0Ija38724YOMya_K1TOE35ac2MU/edit)

**EVALUATION**

**Elaborate on Results with Class (40 minutes)**

1. Regroup the class. With the entire class’s attention, review hypotheses proposed by a group and guide them in the design of an experiment that would address that question using accessible resources.

1. Fully flesh out each group’s project, one at a time. Then move on to the next group and do the same. Experiencing the critical formation process themselves and observing others go through the same will better cement the overall process.

1. Use remaining time to further familiarize students with the greenhouses. Set up contact info between groups and provide general experimental protocol to ensure solid logistics and clear responsibilities for each group.

**Experimental Project Formulation**

* Students should have a solid hypothesis and experimental design to move forward with the project. How well they carry that out will be reflected in attention to detail moving through the project itself and making appropriate adjustments.
* Give students as much freedom as possible to play with experimental setup and just steer them away from irreversible pitfalls.
* See attached protocol guidelines for project success: [Experiment\_guidelines](https://docs.google.com/document/d/1ORwEIfVtCfhGLfOQWtWqL8pj3q1rg1cZJEBuRrYOWaU/edit?usp=sharing)