SELECTED COURSE DESIGN

Scientific Thinking

From questioning claims to constructing and revising scientific arguments

Natalia Borrego | Undergraduate course taught at the American University in Cairo | Fall 2020 sequence shown here

I designed this course around a simple progression: students first learn to ask what a scientific claim means and what would count as evidence; they then practice evaluating research design and inference; by the end of the semester they use those skills together to construct and revise a scientific case study from peer-reviewed literature.

COURSE PROGRESSION

1. Question	**Nature of science.** Scientific thinking; science and non-science; skepticism, empiricism, and rationalism; falsifiability; hypothesis formulation. Classroom cases included DHMO, Clever Hans, Love Potion No. 9, and beri-beri.
2. Test	**Research and evidence.** Research ethics; internal, external, construct, and statistical validity; research methods; correlation and causation; data interpretation and visual representation.
3. Evaluate	**Arguments and literature.** Bias and assumptions; reading peer-reviewed literature; induction, deduction, and abduction; validity and soundness; analyzing and evaluating arguments.
4. Create	**Term project.** Student groups selected a topic, found peer-reviewed articles, wrote literature summaries, developed a case study and questions, submitted an outline and a section for feedback, then revised and completed the final project.

BLOOM'S TAXONOMY IN THE COURSE

Understand → Apply → Analyze → Evaluate → Create

The taxonomy is useful to me as a planning tool rather than a label for individual activities. Early work establishes concepts and vocabulary; subsequent cases require students to apply those ideas to unfamiliar claims; research-validity and literature exercises ask them to analyze and evaluate evidence; the term project asks them to combine those skills in a product of their own.

EXAMPLES FROM THE CLASSROOM

Clever Hans

Students consider whether a horse can answer questions, propose alternative explanations, and decide what evidence would distinguish among them before the historical results are revealed.

Research validity

Students evaluate experimental designs for statistical, internal, construct, and external validity and identify which conclusions are justified by a given design.

Correlation or causation?

Students distinguish association from causal inference, identify uncontrolled variables, and propose additional evidence that would strengthen a claim.

Reading scientific literature

Students identify a paper's research question, evidence, assumptions, and conclusion before they use primary literature in the term project.

ASSESSMENT AND FEEDBACK

Students practice a skill before they are asked to combine it with others.

COURSE WORK	HOW IT FUNCTIONED IN THE COURSE
Blackboard modules and quizzes	Preparation and retrieval practice for concepts used in synchronous discussion and later assignments.
Short case studies	Repeated application of skepticism, hypothesis formulation, evidence evaluation, and inference to unfamiliar examples.
Major homework	Longer work in experimental design, logical reasoning, and quantitative reasoning.
Term project	Students selected a topic, located peer-reviewed literature, developed an outline, submitted a section for feedback, revised, and completed a final case study.

> **What I wanted students to be able to do by the end:** not simply define skepticism, validity, or causation, but use those ideas together - decide what a claim predicts, ask whether a test can answer the question posed, interpret evidence without overstating it, and revise an argument when the evidence demands it.

REPRESENTATIVE SEMESTER SEQUENCE

Weeks 1-4	**Nature of science:** scientific thinking; science vs. pseudoscience; skepticism; empiricism; rationalism; falsifiability; hypothesis formulation.
Weeks 5-9	**Research and evidence:** ethics; research validity; methods; data interpretation; correlation and causation; visual representation of data.
Weeks 10-13	**Evaluating arguments:** biases and assumptions; peer-reviewed literature; logical reasoning; induction, deduction, and abduction; validity and soundness.
Weeks 14-15	**Creating and revising:** literature synthesis; case-study construction; question development; section-level feedback; revision; final submission.

COURSE-DESIGN NOTE

The Fall 2020 schedule alternated synchronous Zoom discussions with asynchronous Blackboard work. The format changed because of the pandemic; the underlying design did not. Students prepared before discussion, used class time to work through cases and problems, and returned to the same reasoning skills in progressively less scaffolded assignments.