

Research Methods

Most scientists agree that learning about science has two aspects: learning material that has already been established (for example, the structure of DNA, how to find forces on blocks being pushed up a ramp, the definition of an acid) and learning how scientists gained this knowledge (for example, how new discoveries gain authority and are adopted by the scientific community, how to evaluate scientific claims when they conflict, how to design and carry out investigations to answer new questions). Most high school and college science courses are mainly devoted to presenting the first type of knowledge. Education in the second aspect of science has traditionally been left mainly to graduate school. UTeach believes it should become part of high school and college curricula as well because this second aspect of science is the most important in the long run for most citizens to know. Research Methods simultaneously provides students specific techniques needed to address scientific questions and an example of how to provide this sort of training for students through individualized instruction.

The purpose of this course is to present UTeach students with the tools scientists use to solve scientific problems. These tools enable scientists to develop new knowledge and insights, the most important of which are eventually presented in textbooks and taught in conventional science classes. These tools include use of experiments to answer scientific questions, design of experiments to reduce systematic and random errors, use of statistics to interpret experimental results and deal with sampling errors, mathematical modeling of scientific phenomena, and oral presentation of scientific work.

Research Methods is primarily a laboratory course, and most of the topics covered are developed in connection with four independent inquiries UTeach students design and carry out. It is also a substantial writing component class, and the written inquiries students produce are evaluated as examples of scientific writing.

Course Objectives: Research Methods

Students Will Be Able To:	Evidence (Student Products)
Use experiments to answer scientific questions	Four papers on four separate independent inquiries, designed and carried out by the student: (1) brief home inquiry, (2) laboratory inquiry using high school equipment, (3) survey involving human subjects, and (4) extended laboratory inquiry
Design experiments to reduce systematic and random errors	Papers on inquiries 2, 3, and 4 Proposals for inquiries 2 and 4
Use statistics to interpret experimental results and deal with sampling errors	Two homework assignments Two brief in-class papers Class performance Write-ups for inquiries 2, 3, and 4
Use probes and computers to gather and analyze data	Instructor observations during inquiry 2 or 4 or both

Ethically treat human subjects	Certificate demonstrating completion of human subjects training Satisfactory completion of inquiry 3, which involves human subjects
Apply safe laboratory procedures	Instructor observations during inquiries 2 and 4
Find and read articles in the current scientific literature	Two homework assignments Performance assessment during debate
Model scientific phenomena mathematically (Expectations depend upon mathematical skills of student and are greatest for math majors.)	Two homework assignments Personalized modeling assignments as part of inquiries 2 and 4
Apply scientific arguments in matters of social importance	Debates carried out in class in teams at end of semester
Write scientific papers	Four written inquiries, with inquiries 2 and 4 involving at least two drafts
Review scientific papers	Student evaluations of each other, in pairs
Oral presentation of scientific work	In-class oral reports on inquiries 2 and 4 Debate presentation