

Course Description: 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. FSU-Teach 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 FSU-Teach 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 FSU-Teach 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 Procedures: Research Methods

Research Methods is cross-listed between the Physics, Chemistry, and Biology departments. Math students are encouraged to take the Physics section because connections between math and physics are particularly strong, and the chances of finding a project with substantial mathematical content increase. All cross-listed versions are identical, except that each student must perform the final inquiry in the discipline for which she or he signed up.

The class is divided into classroom sections and lab sections. Classroom sections meet two hours per week on two separate days, and lab sections meet two contiguous hours per week.

Research Methods is a substantial writing component course. Therefore, inquiries are evaluated both on content and the quality of written expression. There are no formal examinations.

Course Objectives: Research Methods

Students Will Be Able To:

Use experiments to answer scientific questions

Design experiments to reduce systematic and random errors

Use statistics to interpret experimental results and deal with sampling errors

Use probes and computers to gather and analyze data
Ethically treat human subjects

Apply safe laboratory procedures

Find and read articles in the current scientific literature

Model scientific phenomena mathematically (Expectations depend upon mathematical skills of student and are greatest for math majors.)

Apply scientific arguments in matters of social importance
Write scientific papers

Review scientific papers

Evidence (Student Products)

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

Papers on inquiries 2, 3, and 4
Proposals for inquiries 2 and 4

Two homework assignments
Two brief in-class papers
Class performance
Write-ups for inquiries 2, 3, and 4

Instructor observations during inquiry 2 or 4 or both
Certificate demonstrating completion of human subjects training
Satisfactory completion of inquiry 3, which involves human subjects

Instructor observations during inquiries 2 and 4

Two homework assignments
Performance assessment during debate

Two homework assignments
Personalized modeling assignments as part of inquiries 2 and 4

Debates carried out in class in teams at end of semester
Four written inquiries, with inquiries 2 and 4 involving at least two drafts

Student evaluations of each other, in pairs

Oral presentation of scientific work

In-class oral reports on inquiries 2 and
4

Debate presentation