

Vision Statement

We develop educational leaders who create tomorrow's opportunities.

Mission Statement

Our mission is to prepare competent professionals who will make positive differences for children, young adults, and others in schools.

**SCI 613: Nature of Science: Historical and Philosophical Perspectives
Fall 2015: Synchronous online
3 credit hours**

General Information:

Instructor: Ron Gray, Ph.D.

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Office Hours: TBD



Over the course of human history, people have developed many interconnected and validated ideas about the physical, biological, psychological, and social worlds. Those ideas have enabled successive generations to achieve an increasingly comprehensive and reliable understanding of the human species and its environment. The means used to develop these ideas are particular ways of observing, thinking, experimenting, and validating. These ways represent a fundamental aspect of the nature of science and reflect how science tends to differ from other modes of knowing.

Science for All Americans, p. 1

Course Prerequisites: None.

Course Description: This course reviews the history of scientific thought from the philosophical perspective. Students will examine the nature of science, the history and philosophy of science for issues in science education.

Student Learning Expectations/Outcomes: As a result of this course, students will be able to:

1. Understand the central issues in the philosophy, history, and sociology of science.
2. Examine multiple case studies of science to explore scientific methodologies.
3. Explain the diversity of scientific methodologies present in modern science.
4. Describe and utilize the nature of science in terms of work in the science classroom.
5. Describe how scientists use the scientific practices highlighted in the Next Generation Science Standards.

6. Provide examples of the integration of scientific practices into the classroom.
7. Identify scientific models from primary scientific articles.
8. Practice professional patterns of communication including writing at a Master's level.

Course Structure/Approach: Hybrid, large and small group discussion, readings, use of educational technologies, presentations and personal reflection in hybrid face-to-face or online formats.

Textbook and Required Materials:

Grinnell, F. (2008). *Everyday Practice of Science: Where Intuition and Passion Meet Objectivity and Logic: Where Intuition and Passion Meet Objectivity and Logic*. Oxford University Press.

Additional chapters and articles available through Google Drive.

Recommended Materials:

National Research Council (2011). *A Framework for K-12 Science Education*. Washington, D. C.: National Academy Press. (http://www.nap.edu/catalog.php?record_id=13165)

Michaels, S., Shouse, A.W. & Schwingruber, H.A. (2007). *Ready, Set, Science: Putting Research to Work in K-8 Science Classrooms*. National Academy Press. ISBN: 0-309-10614-1. Available for free online at: http://www.nap.edu/catalog.php?record_id=11882#toc

Duschl, R.A., Schwingruber, H.A. & Shouse, A.W. (2007). *Taking Science to School: Learning and Teaching Science in Grades K-8*. National Academy Press. ISBN: 0-309-10205-7. Available for free online at: http://www.nap.edu/catalog.php?record_id=11625

Achieve, I. on behalf of the twenty-six states and partners that collaborated on the N. (2013). *Next Generation Science Standards*. Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS. Available at: <http://www.nextgenscience.org/>

Emergency Textbook Loan Program: To help students acquire the materials they need to be successful in class. NAU has partnered with Follett to create the Emergency Textbook Loan program. The program is administered by the LEADS Center. The program assists students with unmet financial need in obtaining required textbook(s) and other materials for courses. Students must apply and meet eligibility criteria before textbooks are purchased on their behalf. Textbooks must be returned at the end of the term in which the textbooks were loaned. More information can be found online: <http://nau.edu/LEADS-Center/Textbook-Loan-Program/>

Course Outline: (*very subject to change*)

Week	Date	Topic	Major Assignments Due
1	9/3	Course introduction	
2	9/10	What have we learned from the philosophy of science? from the history of science?	
3	9/17	What have we learned from the history of science?	
4	9/24	What have we learned from the sociology of science?	

5	10/1	What have we learned from the scientists themselves?	
6	10/8	How do scientists construct scientific knowledge?	
7	10/15	Is there a singular scientific method? What is the terminology of science?	Classroom context paper
8	10/22	How has the work of the philosophy, history, and the science studies communities been translated to the K-12 context?	
9	10/29	How can we use the nature of science to teach controversial topics?	
10	11/5	What pedagogical approaches can be used to teach NOS?	
11	11/12	What pedagogical approaches can be used to teach NOS?	
12	11/19	What pedagogical approaches can be used to teach NOS?	Science-in-action report
13	11/26	Veteran's Day – No Class	
14	12/3	What are the practices of science and how can they be used in the classroom?	NOS Lesson NOS Journal
15	12/10	What do the scientific practices look like in the classroom?	Scientific practice presentation
16		FINAL	Final Exam Annotated Bibliography

Bibliography of Course Readings (subject to change):

- American Association for the Advancement of Science [AAAS]. (1990). *Science for all Americans*. New York: Oxford University Press.
- Bailer-Jones, D. M. (2002). Scientists' Thoughts on Scientific Models. *Perspectives on Science*, 10(3), 275–301.
- Bauer, H. H. (1992). *Scientific Literacy and the Myth of the Scientific Method* (p. 192). Chicago: University of Illinois Press.
- Ben-Ari, M. (2005). *Just a Theory: Exploring the Nature of Science* (p. 237). Prometheus Books.
- Collins, H., & Pinch, T. (1998). *The Golem: What you should know about science* (2nd ed.). Cambridge: Cambridge University Press.
- Duschl, R. A., & Grandy, R. (2012). Two Views About Explicitly Teaching Nature of Science. *Science & Education*, 23–25.
- Duschl, R. A., Schweingruber, H. A., & Shouse, A. W. (2007). *Taking science to school: Learning and teaching science in grades K-8* (p. 387). Washington, D.C.: National Academies Press.
- Farber, P. (2003). Teaching evolution & the nature of science. *The American Biology Teacher*, 65(5), 347–354.
- Giere, R. N., Bickle, J., & Mauldin, R. (2005). *Understanding Scientific Reasoning* (p. 308). Orlando, FL: Harcourt Brace College Publishers.
- Gimbel, S. (Ed.). (2011). *Exploring the scientific method: Cases and questions*. Chicago: The University of Chicago Press.

- Grinnell, F. (2008). *Everyday Practice of Science: Where Intuition and Passion Meet Objectivity and Logic: Where Intuition and Passion Meet Objectivity and Logic* (p. 248). Oxford University Press.
- Hodson, D. (2008). *Towards scientific literacy: A teachers' guide to the history, philosophy and sociology of science*. Rotterdam, The Netherlands: Sense Publishers.
- Latour, B. (1988). *Science in Action: How to Follow Scientists and Engineers Through Society* (p. 287). Cambridge, MA: Harvard University Press.
- Latour, B. (1999). *Pandora's hope: Essays on the reality of science studies*. Harvard University Press.
- Michaels, S., Shouse, A. W., Schweingruber, H. A., & Council, N. R. (2007). *Ready, Set, SCIENCE!: Putting Research to Work in K-8 Science Classrooms* (Vol. 2007, p. 203). Washington, D.C.: National Academies Press.
- National Research Council [NRC]. (2011). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. (p. 282). Washington, D.C.
- NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.
- Oh, P. S., & Oh, S. J. (2011). What Teachers of Science Need to Know about Models: An overview. *International Journal of Science Education*, 33(8), 1109–1130.
- Okasha, S. (2002). *Philosophy of Science: A Very Short Introduction* (p. 160). Oxford University Press.
- Rudolph, J. L. (2000). Reconsidering the “nature of science” as a curriculum component. *Journal of Curriculum Studies*, 32(3), 403–419.
- Rudolph, J. L. (2005). Epistemology for the Masses: The Origins of “The Scientific Method” in American Schools. *History of Education Quarterly*, 45(3), 341.
- Rudolph, J. L., & Stewart, J. H. (1998). Evolution and the nature of science: On the historical discord and its implications for education. *Journal of Research in Science Teaching*, 35(10), 1069–1089.
- Sagan, C., & Druyan, A. (1997). *The Demon-Haunted World: Science as a Candle in the Dark* (p. 457). New York: Ballantine Books.
- Wong, S. L., & Hodson, D. (2009). From the horse's mouth: What scientists say about scientific investigation and scientific knowledge. *Science Education*, 93(1), 109–130. doi:10.1002/sce.20290
- Wong, S. L., & Hodson, D. (2010). More from the Horse's Mouth: What scientists say about science as a social practice. *International Journal of Science Education*, 32(11), 1431–1463.

Assessment of Student Learning Outcomes:

All assignments must be turned in through Google Drive.	Percent
Participation: Students are expected to attend every class and engage in class activities. Frequently, in-class activities will include individual and group written work. This grade is holistic and will be based on attendance, preparation, and willingness to engage in activities as evidenced by these informal assignments.	20%
Classroom context paper	15%
Science-in-action report	15%
Annotated bibliography	10%
NOS Journal	10%
NOS lessons	10%

Scientific practice presentation	10%
Final written exam	10%
Total Possible:	100%

Late policy: All assignments must be submitted to Google Drive by the beginning of class time **on or before** the due date. Points will be deducted at 10% per day of earned points up to one week late.

Scores on all assignments will be made available on Google Drive.

The following is a brief description of the assignments that will be completed as a part of this class as well as their point value. Additional descriptions and specific evaluation criteria for these assignments will be provided.

- A. Classroom context paper. After studying what we have learned about science from the philosophy of science, history of science, and science studies as well as from scientists themselves, you will summarize your thoughts on what understandings are important in the K-12 or community college context.
- B. Science-in-action report. For this assignment, you will read a book-length account of the scientific enterprise (e.g. *The Double Helix: A Personal Account of the Discovery of the Structure of DNA*, or *A Feeling for the Organism: The Life and Work of Barbara McClintock*). You will compare the account to course ideas, making connections, finding examples, and discovering discrepancies. You will be asked to write a short written report of your findings as well as to weave your observations into class discussions.
- C. Annotated bibliography. The course readings should be not only informative, but also serve as a reference for future research and writing. For each reading, create a short summary including an evaluation of the source to be used as part of a literature review for the course (or future) paper. This should be a short paragraph of around 4-5 sentences. Compile these summaries into an annotated bibliography.
- D. NOS Journal. You will record multiple reflection in your NOS Journal. Each reflection should focus on where you saw explicit NOS in your classroom or where a missed opportunity occurred. It may also address your own ideas for including explicit NOS in your classroom and/or the language we use around NOS in the classroom. Reflections will occur in the second half of the term.
- E. NOS lessons. You will design a multi-day lesson that integrates NOS and content.
- F. Scientific practice presentation. As a group project, you will examine a scientific practice in detail and provide examples of lessons highlighting that practice.
- G. Final Exam. This will be an open-note essay exam based on course content, including major terms and concepts from readings, supplementary materials, and discussions. Students will be required to synthesize their thoughts; communicate complex ideas related to the nature, history, and philosophy of science; and meaningfully apply their understanding of course concepts in an educational context.

Grading System:

Completing assignments correctly documents current knowledge and ability level, including the ability to follow instructions. Grades will be based both on the quality of work turned in as well as the percentage of number of assignments turned in. Each of the above listed common

assignments counts as one assignment with the exam counting as two assignments. Quality of work will be scored according to the following scheme.

% of Points	Quality of Work
100%	Excellent (A/A-): All aspects of the work are complete and well above the minimum level specified. Well written and free of typographical and grammatical errors. APA format consistently and accurately used. Evidence of careful reading, thought, reflection, and/or analysis. Synthesizes personal experience, beliefs, and course content.
80%	Average (B): Two or more of the above elements missing or of lesser quality.
75%	Acceptable (C): The task was completed at the minimum level specified. Most aspects of the assignment were attended to with written work that indicates a focus on task completion as opposed to careful reflection, analysis, and/or application. <i>While a grade of a C implies that the assignment met minimum requirements, and was therefore acceptable, a grade of C is NOT acceptable for graduate level work.</i>
Below 50%	Not acceptable (F) Aspects of the assignment are missing or completed at a sub-standard level.

Final course grade will be based on the total points received from the assignments and measured against the grading scale below. There will be no curve.

A = 90 – 100%

C = 70 – 79.5%

B = 80 - 89.5%

F = Below 50%

Course Policies:

- Regular and active participation is expected. Attendance is required. Any absence beyond the first one that is not pre-approved by the instructor will result in reduction in points.
- No cell phones may be visible in class. Cell phones must be turned off. Cell phones in class are extremely disrespectful to the instructor and fellow colleagues. You are not exempted from this rule. This rule applies equally to all.
- You must evacuate the building if the fire alarm sounds.
- Joint responsibilities regarding classroom behavior:
<http://www4.nau.edu/stulife/handbookmanagement.htm>
- All written assignments must be word processed and submitted electronically in pdf or word format. Writing errors such as spelling, punctuation, grammatical errors, etc., will be taken into consideration; any assignment with more than four errors will be returned for revision before grading. All assignments should be professional in appearance. Students are permitted and encouraged to proofread each other's assignments. APA guidelines must be followed for formal papers.
- Contact the instructor immediately in case of any special circumstances or emergency situations.
- Problems with computer hardware or software will not be accepted as excuses for handing in work after the due date.
- Additional assignments will NOT be given for extra credit.

- Assignments submitted as a requirement for another class should not be submitted for this class without permission from the instructor. All assignments should be the original work of the student completed for this class. If lab activities or lesson plans from another source are used and/or modified by the student for this course, a proper citation to the original author must be provided. I use technology to check for plagiarism.
- Statement on plagiarism and cheating: Working with other learners on course projects is a fundamental aspect of this course and is heartily encouraged. However, when working with other learners to complete an assignment, submit your own work, not a copy of someone else's work. Also, **be extremely careful to reference outside sources when using them as part of one of your assignments.** Instances of plagiarism or cheating will be reported to the Dean for disciplinary action and may result in a failing grade for the course.
- **Instructor/Course Evaluations:** When it gets close to the end of the course, all students are asked to complete a course evaluation at through http://www.nau.edu/course_evals/.

The instructor reserves the right to revise the syllabus, assignments and course evaluation criteria. Students will be immediately notified of any of these changes in advance of any changes taking effect.

Northern Arizona University Policy Statements available at:
<http://jan.ucc.nau.edu/academicadmin/plcystmt.html>

NORTHERN ARIZONA UNIVERSITY

POLICY STATEMENTS

NAU's Safe Working and Learning Environment Policy prohibits sexual harassment and assault, and discrimination and harassment on the basis of sex, race, color, age, national origin, religion, sexual orientation, gender identity, disability, or veteran status by anyone at this university. Retaliation of any kind as a result of making a complaint under the policy or participating in an investigation is also prohibited. The Director of the Office of Affirmative Action & Equal Opportunity (AA/EO) serves as the university's compliance officer for affirmative action, civil rights, and Title IX, and is the ADA/504 Coordinator. AA/EO also assists with religious accommodations. You may obtain a copy of this policy from the college dean's office or from the NAU's Affirmative Action website nau.edu/diversity/. If you have questions or concerns about this policy, it is important that you contact the departmental chair, dean's office, the Office of Student Life (928-523-5181), or NAU's Office of Affirmative Action (928) 523- 3312 (voice), (928) 523-9977 (fax), (928) 523-1006 (TTD) or aaeo@nau.edu.

STUDENTS WITH DISABILITIES

If you have a documented disability, you can arrange for accommodations by contacting Disability Resources (DR) at 523-8773 (voice) or 523-6906 (TTY), dr@nau.edu (e-mail) or 928-523-8747 (fax). Students needing academic accommodations are required to register with DR and provide required disability related documentation. Although you may request an accommodation at any time, in order for DR to best meet your individual needs, you are urged to register and submit necessary documentation (www.nau.edu/dr) 8 weeks prior to the time you wish to receive accommodations. DR is strongly committed to the needs of student with disabilities and the

promotion of Universal Design. Concerns or questions related to the accessibility of programs and facilities at NAU may be brought to the attention of DR or the Office of Affirmative Action and Equal Opportunity (523-3312).

ACADEMIC CONTACT HOUR POLICY

Based on the Arizona Board of Regents Academic Contact Hour Policy (ABOR Handbook, 2-224), for every unit of credit, a student should expect, on average, to do a minimum of three hours of work per week, including but not limited to class time, preparation, homework, studying.

ACADEMIC INTEGRITY

Integrity is expected of every member of the NAU community in all academic undertakings. Integrity entails a firm adherence to a set of values, and the values most essential to an academic community are grounded in honesty with respect to all intellectual efforts of oneself and others. Academic integrity is expected not only in formal coursework situations, but in all University relationships and interactions connected to the educational process, including the use of University resources. An NAU student's submission of work is an implicit declaration that the work is the student's own. All outside assistance should be acknowledged, and the student's academic contribution truthfully reported at all times. In addition, NAU students have a right to expect academic integrity from each of their peers.

Individual students and faculty members are responsible for identifying potential violations of the university's academic integrity policy. Instances of potential violations are adjudicated using the process found in the university [Academic Integrity Policy](#).

RESEARCH INTEGRITY

The Responsible Conduct of Research policy is intended to ensure that NAU personnel including NAU students engaged in research are adequately trained in the basic principles of ethics in research. Additionally, this policy assists NAU in meeting the RCR training and compliance requirements of the National Science Foundation (NSF)-The America COMPETES Act (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science); 42 U.S.C 18620-1, Section 7009, and the National Institutes of Health (NIH) policy on the instruction of the RCR (NOT-OD-10-019; "Update on the Requirement for Instruction in the Responsible Conduct of Research"). For more information on the policy and the training activities required for personnel and students conducting research, at NAU, visit:

<http://nau.edu/Research/Compliance/Research-Integrity/>

SENSITIVE COURSE MATERIALS

University education aims to expand student understanding and awareness. Thus, it necessarily involves engagement with a wide range of information, ideas, and creative representations. In the course of college studies, students can expect to encounter—and critically appraise—materials that may differ from and perhaps challenge familiar understandings, ideas, and beliefs. Students are encouraged to discuss these matters with faculty.

CLASSROOM DISRUPTION POLICY

Membership in the academic community places a special obligation on all participants to preserve an atmosphere conducive to a safe and positive learning environment. Part of that obligation implies the responsibility of each member of the NAU community to maintain an environment in which the behavior of any individual is not disruptive. Instructors have the authority and the responsibility to manage their classes in accordance with University regulations. Instructors have the right and obligation to confront disruptive behavior thereby promoting and enforcing standards of behavior necessary for maintaining an atmosphere conducive to teaching and learning.

Instructors are responsible for establishing, communicating, and enforcing reasonable expectations and rules of classroom behavior. These expectations are to be communicated to students in the

syllabus and in class discussions and activities at the outset of the course. Each student is responsible for behaving in a manner that supports a positive learning environment and that does not interrupt nor disrupt the delivery of education by instructors or receipt of education by students, within or outside a class. The complete classroom disruption policy is in Appendices of [NAU's Student Handbook](#).