

## The Nature of Science Across Time and Culture The Processes and Practices of Science



### Biology 484x/684, Chemistry 490x, Enviro 475x, Geology 475, and Physics 490x 2 Cr.

This course is an examination of major concepts in the nature of science and how they evolved. This course compares and contrasts of the role and practice of science in various cultures and examination of the interaction between science, technology and culture. CREQ: ILAS 201, 301 or 401; Instructor Permission.

#### Instructor Information - Fall 2018

- **Instructor Name:** Paul Fix
- **Office Location:** Faraday Hall 326
- **Office Hours:** Tues. 9-12, Thurs. 1-3
  - **Send an email if you need to schedule an appointment outside of office hours.**
- **Telephone:** (815) 753-6819
- **Email:** [pfix@niu.edu](mailto:pfix@niu.edu)

#### Meeting Days/Times/Location

Class meetings will be held in **Faraday 129** on **Wednesdays** from **4:00-5:50 PM**.

#### Materials

Book required for the course:

- Konick-Moran, R., & Keeley, P. (2015). *Teaching for Conceptual Understanding in Science*. Arlington, VA: NSTA Press.

Suggested Reading (not required):

- Ben-Ari, M., (2005) *Just a Theory: Exploring the Nature of Science*. Prometheus Books. (ISBN-10: 1591022851/ISBN-13: 978-1591022855)
- Dawkins, R., (2011) *The Magic of Reality: How We Know What's Really True*. Free Press. (ISBN-10: 9781451675047/ISBN-13: 978-1451675047)
- Project 2061 (American Association for the Advancement of Science). (1989). *Science for all Americans: A Project 2061 report on literacy goals in science, mathematics, and technology*. Washington, D.C: American Association for the Advancement of Science. Online version: <http://www.project2061.org/publications/sfaa/online/sfaatoc.htm>

#### Standards Addressed by This Course

- **NSTA Teaching Standards (2012): 2a, 2b, 2c, 3a, 3b, 5b, 5c, 6a, 6b**
- **Next Generation Science Standards (NGSS):** Appendix H, Nature of Science in the NGSS
  - Scientific Investigations Use a Variety of Methods
  - Scientific Knowledge is Based on Empirical Evidence
  - Scientific Knowledge is Open to Revision in Light of New Evidence
  - Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
  - Science is A Way of Knowing
  - Science is a Human Endeavor
  - Science Addresses Questions About the Natural and Material World

#### Course Website

**Blackboard.** Note that you will need to use your Z-ID and because this course is cross-listed, each one of you will be put into GEOL 475 Master course. You will need to test whether you have access twenty-four hours after the first class. If you do not, it will be your responsibility to contact the instructor immediately.

## Course Goals

It is well founded that people learn least when simply being told how something is done or what concepts to understand. Profound learning occurs when we are able to scaffold our understanding of material to a prior or shared experience. One can learn or memorize the basic tenets of the nature of science, but without an experience or concept in which to “hang” the information, a true appreciation of the complexity of the nature of science is difficult. This course will allow the secondary science licensure student an opportunity to begin to practice their teaching while learning the basic tenets of the nature of science.

By the end of this course, students will be able to:

1. Apply the basic tenets of the nature of science and the process of science to a science classroom.
2. Define, differentiate, and provide examples of the types of scientific inquiry.
3. Differentiate between the three dimensions of the Next Generation Science Standards (NGSS) and explain how they interrelate.
4. Explain the importance of teaching the NOS and impact on their students.
5. Apply research on how students learn to demonstrations, lessons, and case studies.
6. Show growth in one or more teaching demonstration core competencies.

## Expectations

We will set a standard of professional comportment, in which professional behavior, including attendance, dress, participation, courtesy, and the submission of assignments by the due date are both expected and required. Professional demeanor, of the type that we expect in the educational workplace, is required at all times in this course. Please silence your cell phone and other electronic devices during class.

## Attendance

Should you need to be late, leave early, or miss a class, please notify me in writing (email is fine) as much in advance as possible. Failure to notify me in writing of an absence *before class* will be regarded as an unexcused absence and there will be no make-up assignments, quizzes or tests. Due to the nature of the course and the work involved, attendance is very important. If you must miss class, it is your responsibility to get the notes from a classmate and to find out what went on in class during your absence.

**In addition, 10 attendance points will be given for each class period that you fully attend and participate in.** If you are late or have to leave early, only 5 points will be awarded for the period. If you are absent, 0 points will be awarded for that period. There will be no make-up for lost attendance points.

## Assignments

You will be expected to complete a number of assignments throughout the semester. I will announce clear deadlines and these assignments must be handed *before the beginning of class*. **Late assignments turned in after class has begun will receive half credit.** Assignments that are one week or more late will not be accepted and a zero will be recorded in the grade book.

## Tests and Quizzes

Test and Quizzes (not the final exam) will be given by way of Blackboard. It is your responsibility to make sure your computer works with Blackboard technology. It is important to notify me immediately if you cannot access the material on blackboard. Questions will consist of a blend of T/F, multiple choice, definitions, short answer, and essay questions.

## Project and Presentations

There will be opportunities to conduct laboratory exercises during the semester. You may work with a partner for these projects and both parties will receive the same grade for project produced. In addition, you will be expected to give a two teaching demonstrations. You will be able to use the technology that is available in the room for your demos. If you need lab materials or equipment, please contact me at least *a week before your demo*.

### **Graduate Credit for Biology 684**

Graduate students will be required to present research from two different peer-reviewed academic journals in a discipline of their choice and in the field of science education. The presentation details and grading rubric can be downloaded from blackboard in the "Scientific Journal Article Presentation" file.

#### **Grading:**

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|---|-----|
| ● Assignments (HW, discussion boards, activities, readings) | 40% |
| ● Anticipatory Set Demo                                     | 10% |
| ● Discrepant Event Demo                                     | 20% |
| ● Quizzes   | 10% |
| ● Attendance  | 5%  |
| ● Final Exam  | 15% |

#### **Accommodations**

If you need an accommodation for this class, please contact the Disability Resource Center as soon as possible. The DRC coordinates accommodations for students with disabilities. It is located on the 4th floor of the Health Services Building, and can be reached at 815-753-1303 or [drc@niu.edu](mailto:drc@niu.edu).

Also, please contact me privately as soon as possible so we can discuss your accommodations. Please note that you will not be required to disclose your disability, only your accommodations. The sooner you let me know your needs, the sooner I can assist you in achieving your learning goals in this course.

#### **Course Outline and Schedule on Next Page**



| Date  | Topic   | Nature of Science, Fall 2018   | Assignments Due   |
|-------|---|--|---|
| 8/29  | <b>Wk 1: Science...is a Process.</b>  | Introductions and Program Overview and Expectations<br>NOS survey<br>Pseudoscience vs science  |   |
| 9/5   | <b>Wk 2: Science...Uses a Variety of Methods.</b>                                     | Introduce Professional Knowledge and Skills assignment<br>What is the "Scientific Method"?<br>Email Activity<br>Introduce Anticipatory set demo  | DUE: Umbrellaology Discussion board, Horoscope Activity                         |
| 9/12  | <b>Wk 3: Science is...a way of knowing</b>  | Types of Research<br>Introduction to NGSS<br>AMNH case studies   | DUE: 3 Anticipatory set ideas, Email Activity                                   |
| 9/19  | <b>Wk 4: Science instruction is...Guided by the Next Generation Science Standards</b> | Peer review/feedback on anticipatory set<br>Discuss case studies – Part I<br>Introduce "how to write objectives"   | DUE: AMNH Case studies - Part I<br>Quiz 1<br>Anticipatory Set Planning document |
| 9/26  | <b>Wk 5: Science...as practice</b>  | <b>Anticipatory set demos (30 min)</b><br>History and levels of inquiry<br>Moving from scientific <i>inquiry</i> to science <i>practice</i><br>Discuss AMNH case studies – Part II<br>Modifying lab activity | DUE: AMNH Case studies – Part II  |
| 10/3  | <b>Wk 6: Science Knowledge is...built from prior knowledge and understandings.</b>    | <b>Anticipatory set demos (30 min)</b><br>Present modified inquiry labs<br>"Minds of Our Own" / "private universe"<br>Preconceptions/misconceptions and conceptual change                                    |   |
| 10/10 | <b>Wk 7: Science... addresses questions about the natural world</b>                   | <b>Anticipatory set demos (30 min)</b><br>Discuss readings and their implications<br>Misconceptions activity<br>Intro discrepant event demo  | DUE: Common misconceptions in Science   |
| 10/17 | <b>Wk8: Science... constructs explanations</b>  | <b>Anticipatory set demos (30 min)</b><br>Induction vs deduction & the scientific approach<br>Laetoli footprints activity  | DUE: 301 application, Quiz 2  |
| 10/24 | <b>Wk 9: Science is...Driven by Observations and Hypotheses</b>                       | Hypothesis, observation vs inference, precision vs. accuracy, validity vs reliability<br>Hypothesis activity   | DUE: NIU Safety tutorial  |
| 10/31 | <b>Wk 10: Science knowledge is...Open to Revision</b>                                 | Discrepant event peer review<br>Fact vs theory vs law, scientific debate, values/ethics/shared principals that guide scientists<br>Taung child   | DUE: Discrepant event ideas, Hypothesis activity                                |

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| 11/7  | <b>Wk 11: Science knowledge is...Based on Empirical Evidence</b>                                   | <b>Discrepant event (50 min)</b><br>Using data as evidence, causation vs correlation, interpolation vs extrapolation notes.<br>Dialysis tubing/diffusion lab | DUE: Quiz 3                                     |
| 11/14 | <b>Wk 12: Science knowledge is...Built by Obtaining, Evaluating, and Communicating Information</b> | <b>Discrepant event (50 min)</b><br>Peer reviewing, communicating information<br>Dialysis tubing analysis and results  | DUE: Science for all Americans discussion board |
| 11/21 | <b>THANKSGIVING BREAK</b>  |  |   |
| 11/28 | <b>Wk 13: Science is...a Human Endeavor</b>  | <b>Discrepant event (50 min)</b><br>Culture influence on science and vice versa<br>Bias in Science<br>Diversity in Science                                   | DUE: Quiz 4                                     |
| 12/5  | <b>Wk 14: Science Literacy is...important for all.</b>   | <b>Discrepant event (50 min)</b><br>Why is it important to teach NOS?<br>Obstacles to teaching NOS<br>Scientific Literacy                                    | DUE: Scientific Literacy Assignment             |
| 12/12 | <b>FINAL EXAM 4:00 - 5:50pm</b>  | Final Exam   |   |