Overview
Natural Science Inquiry is designed to engage you in scientific inquiries of problems of the sort you might encounter as an attentive citizen. Using case studies and research, we will be exploring what it means to engage topics scientifically. You will also conduct scientific investigations using the skills we have developed, from defining how to go about framing questions, interpreting articles, obtaining data, doing the necessary library research, and arriving at substantiated (thus persuasive) conclusions. Your investigations will involve the use of collaborative inquiry and take account of the fact that the modern sciences, as well as the questions they address, require teamwork both within and between specific disciplines. We wish to create a context within which this sort of teamwork is required to address the problems put before you.

As you will see right away, the schedule of events does not look like the listing of lectures and exams characteristic of a typical science course. Instead, learning in NSI is accomplished through inquiry-based projects on a variety of topics. The successful completion of these projects requires that you: 1) work independently and collaboratively, 2) use the PSU library and associated databases to access scientific articles, 3) collect and/or obtain data, 4) use computers to organize, analyze, and present data, and 5) interpret, make, and defend knowledge claims through oral and written presentations.

Course Goals
• To develop an understanding of the nature of scientific inquiry and reasoning through case studies, scientific investigations, analysis and presentation.
• To increase the ability to investigate and evaluate questions of science through resources available in libraries and the Internet.
• To develop a familiarity with the some of the mathematical, computational and research tools of scientific inquiry.

Expectations
• Be prepared for class
  o Arrive on time (absence will result in the loss of participation points)
  o Communicate and collaborate with your classmates on group assignments.
  o Read assigned papers and come to class with assignments completed.
• Participate in class activities
  o Be aware that good grammar, clear structure and scientific reasoning will all be incorporated into your grades.
  o For goodness’ sake, take notes. My notes will not be available to you online or otherwise.
• Ask Questions!
### Tentative Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>#</th>
<th>Topic, due dates*</th>
<th>Homework</th>
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<td>Introduction to Course: Ways of Knowing</td>
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<td>TH 1/7</td>
<td>2</td>
<td>Science-Pseudoscience; The Scientific Method</td>
<td>Ch 1,2,6</td>
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<td>T 1/12</td>
<td>3</td>
<td>Getting data: Experimental design</td>
<td>Ch 3,4,5, Lake Woebegone</td>
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<td>TH 1/14</td>
<td>4</td>
<td>Faulty reasoning, probability</td>
<td>Ch 9,10</td>
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<td>T 1/19</td>
<td>5</td>
<td>Library with Rm 160 with Elizabeth Pickard</td>
<td>Find academic articles for Project I, Library worksheet, Lady Tasting Tea</td>
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<td>TH 1/21</td>
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<td>An average Tree, probability</td>
<td>average tree methods</td>
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<td>T 1/26</td>
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<td>Basic Statistics</td>
<td>Ch 7,8</td>
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<td>TH 1/28</td>
<td>8</td>
<td>Using Excel</td>
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<td>T 2/2</td>
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<td>Discuss Project II, Make observations of Nature, scavenger hunt</td>
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<td>TH 2/4</td>
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<td>Project I Oral presentations</td>
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<td>T 2/9</td>
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<td>Asking interesting questions</td>
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<td>TH 2/11</td>
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<td>How to write a Scientific Paper.</td>
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<td>T 2/16</td>
<td>13</td>
<td>Project Day: Begin Data Collection</td>
<td>Hypotheses and design exp. For Project II, Ch 13</td>
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<td>TH 2/18</td>
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<td>Project Day: Complete Data Collection and data entry</td>
<td>Intro &amp; Bibliography,</td>
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<td>T 2/23</td>
<td>15</td>
<td>Project Day: Data Analysis</td>
<td>prelim Results (graphs and results section)</td>
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<td>TH 2/25</td>
<td>16</td>
<td>Science applications:</td>
<td>Science Application Readings</td>
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<td>T 3/1</td>
<td>17</td>
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<td>TH 3/3</td>
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<td>Project Day: Peer Review</td>
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<td>T 3/8</td>
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<td>Project II Oral Presentations</td>
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<td>TH 3/10</td>
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<td>Project II Oral Presentations, Student driven review. Participation progress: final</td>
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*FINAL EXAM*

Changes in reading, writing and project due dates will be announced in class. It is your responsibility to be aware of any changes in due dates, whether or not these were announced in your absence. Assignments are due at the beginning of class. **Late papers will lose 10%/day.**
Evaluation

Participation & assessments  19%
Average tree / Excel  3%
Project I  20%
Hypotheses & Methods draft  2%
Introduction & Bibliography draft  2%
Results draft  2%
Project II review in class  2%
Project II  30%
Comprehensive Exam  20%

100%

Participation & Assessments: This portion of your grade will be based on the degree to which you participate in class discussions, ask questions, and remain attentive to your peers. You will be graded daily: Attend & contribute during class = 6, Assessments = 4pts. You MUST be in contact with me and the TA regarding absences. In class assignments, readings, and completion of homework assignments will also earn you points to your participation grade. Participation is a substantial portion of your grade. In addition to participating in class, there are a number of opportunities for you to actively participate in your group assignments. You group assignment grades will also contain a portion dedicated to participation and will be adjusted accordingly based on group and instructor evaluation. Disruptive behavior will result in loss of participation points and you will be asked to leave the classroom.

Project I (individual project): Find three popular articles that make a reference to some research or specific academic paper. Look up the primary research articles and evaluate the journal for funding source and merit (does the popular article accurately interpret the academic article?)… 1 paragraph each. For one of these pairs, please do a more critical evaluation of the experimental design and how well the results represent the interpretation of the outcome of the study in both the academic and the popular press article … no more than 1 page. Prepare a brief (3 min) oral presentation of your findings for one of your articles. (PLEASE SEE FULL RUBRIC, ATTACHED)

Project II: Choose your own adventure! Project II will be a scientific study of your choosing to be conducted as small group. Your mission is to go out and observe patterns in nature or in people. Based on your observations and careful notes, identify a testable hypothesis. Create a good experimental design that will test your hypothesis and use this design to collect your data. Analyze your data using the basic methods we have discussed in class and write up your findings (individually) as a scientific paper with an Abstract, Introduction, Methods, Results and Discussion section. To give your study context, you will need to include at least 6 peer-reviewed papers. You will also be presenting your findings (as a group) to your classmates at the end of the term in a short powerpoint presentation. (PLEASE SEE FULL RUBRIC, ATTACHED)

Comprehensive exam: The comprehensive exam will be primarily short-answer… 1 word – 1 paragraph responses will be required to be written legibly and reflect the skills and information you have learned in class or from readings. There may be some basic statistical calculations included that can be conducted by hand or with a simple calculator.
Texts:
This course will be using the Handbook of Biological Investigation by Ambrose, I also strongly recommend The Elements of Style by Strunk and White

Homework:
• Assignments must be in on time. I will not accept unexcused late homework, Final project assignments will lose 10% per day.
• Type your homework assignments. Handwritten homework will not be graded.
• Quality is important and is factored into the grade of each assignment
• Although much of the work will be conducted as a class or in small groups, your homework must be your own work. I encourage you to discuss the concepts and interpretations of the data with your classmates, however, you must generate your own reports, graphs, etc... Do not turn in identical or strikingly similar assignments as your classmates (current or anyone who has taken this class previously). You will not receive a score and you risk further academic prosecution for plagiarism.

Classroom Conduct:
• If you choose not to participate in this course, please do not converse or distract the other students, this includes personal use of electronic devices in class, these distract people around you.
• Be considerate of your classmates. Because this class will involve group activities, please come prepared and ready to participate in group and class activities.
• Arrive to class on time. If you arrive late, you disrupt the class activities and will miss valuable information presented at the beginning of class. You are responsible for any material and activities that are conducted in class, even if you are not there!

Academic Conduct:
• Familiarize yourself with the academic code in the University catalog.
• There are many forms of plagiarism, including:
  o Copying word for word without quotation marks and proper citation
  o Closely paraphrasing without proper citation
  o Be especially careful of information obtained from the Internet. In general, for your lab reports do not cite work from the web. Follow the information to its source and cite the primary, peer reviewed literature.
  o Turning in homework that is strikingly similar to other students work.

Project I (individual project)
Find three popular articles that make some sort of scientific claim or a reference to some research or specific academic paper. Look up the primary research articles and evaluate the journal for funding source and merit (does the popular article accurately interpret the academic article?)… One paragraph each. For one of these pairs, please do a more critical evaluation of the experimental design and how well the results represent the interpretation of the outcome of the study in both the academic and the popular press article … no more than 1 page.
RUBRIC for Project 1: Point values in parentheses.
For Articles 1, 2 & 3

✓ Assignment was completed, clearly typed and all portions of the assignment were turned in… including the original articles (10)
✓ All academic and popular articles were clearly referenced. (all (10), some (5), none (0))
✓ Purpose of the popular article explained…. clearly and concisely (1-3 sentences) (5), clearly (but too long) (3), in a vague manner (0).
✓ All (5), some (3), none (0) of the relevant claims in popular article were addressed.
✓ Appropriate (5), Inappropriate (3), No (0) scientific articles were found.
✓ Funding sources for academic articles were identified and evaluated for conflict of interest (all (5), some (3), none (0))
✓ Academic articles were evaluated for merit (was the study conducted well? Use examples) (all (5), some (3), none (0))
✓ One sentence overall conclusion/evaluation of the validity of the popular article and relevant academic support (did the popular article accurately interpret the academic article? Use examples) (5).

Total Possible: 50 points each article

For Article 3 (add to the above rubric)
Evaluation of the experimental design clearly addressed using specific examples from the text(5), sufficiently addressed (3), did not address (0) each of the following:
✓ What sort of data did they use (continuous, discrete), explain
✓ Was this a controlled experiment?
✓ What was the control? Was it an appropriate control?
✓ What was the population of interest? How was it defined?
✓ What were the Hypotheses of the experiment?
✓ Did the data support the hypothesis (hypotheses)?
✓ Were the methods repeatable?
✓ Was there adequate replication (explain, use example)?

Accurately addressed (with specific examples) how well the results were represented by the interpretation of the study in both the academic and the popular press article (10)

Total possible 50 + 50 = 100
Total for whole written assignment 200 points

Project I _RUBRIC (presentation)_

Slide 1: Title (Short and Descriptive, not metaphorical), authorship
Slide 2: Introduction: Clear statement of the nature of the problem. What are the issues you will be presenting? Description of your popular article with at least one claim clearly stated.
Slide 3: Support: Evaluation of the academic article you found (including the funding source, impact factor, validity).
Slide 4: The analysis of the academic article’s methods and results (they tested X, using Y methods and found Z)
Slide 5: Conclusions: Were the results reported appropriately in the popular article? In the academic article interpretation?

Your oral presentation score will be based content (15 points per slide as per above) as well as 25 points on your ability to convey your information (clearly, good pace, readable slides, don’t go over time). You will be evaluated by the instructor, the TA and by your peers. Total = 100 points
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**Project II**

This project will require a literature review (at least 6 peer-reviewed papers), collection and analysis of the data and communication of your findings in a paper and in an oral presentation.

This project will be conducted in small groups. We will be discussing some of our ideas of things we think will be interesting to study then making our initial observations of patterns. Remember these should be conducted as scientific studies. I encourage actual experimental manipulation (as I discussed in lecture), however surveys conducted in a scientific (unbiased) manner may also be appropriate.

**Purpose:** To gain experience researching, designing, conducting and reporting scientific research. You will propose new knowledge or insight to an important issue, concept or theory.

Once your groups are established, assign clear roles for each member:

**Data Manager:** In charge of collating all of the data collected in an organized manner. Makes sure that all group members understand and participate in the analysis of the data and creation of the charts or graphs.

**Experiment (or survey) manager:** Ensures that group members are all very clear on the protocols for data collection and makes sure that datasheets, pencils and all necessary supplies are available at the time of the experiment.

**Schedule manager writing manager:** Sets clear goals and timeline for each section of the project. Sets meeting times and roles in the establishment and collection of data.

**Writing manager** Makes sure that all group members are completing the written portions of the assignment in a timely fashion so that all members can participate in the creation of the oral presentation. In charge of scheduling time to work on the power-point presentation and scheduling time to practice in advance.

The various managers should take responsibility for establishing jobs and maintaining (and enforcing) a timeline for their aspect of the project. The key to a good group project is adherence to your goals and participation.

**Participation:** 30%

This will be evaluated based on a private survey conducted midway and at the end of your project. The student will be evaluated based on quality of input to the group, reliability (did he/she show up on time?), persistence (did the group member get the job done?) and innovation (did the group member substantially contribute to the intellectual development an execution of the project?)

**Paper** (written individually, though discussed thoroughly as a group): 50%

Your paper should be around 7-10 (max) pages, 1 ½ line spacing. Graphs and figures in this case can be the same for all group members. You will need at least 6 primary research papers to discuss in your papers.

**Presentation:** Prepared and given as a group: 20%

The presentation will be 10 minutes + 5 minutes for questions and should include slides for all of the sections that are represented in your paper.
Natural Science Inquiry  Project II  RUBRIC INDIVIDUAL PAPER

_____ : Project was completed in full, well written without grammatical or spelling errors, meets page requirement. (10 pts). Paper contains some spelling and grammatical errors, though mostly readable, (7 pts). Project not complete, contains serious grammatical errors, contains sentence fragments, difficult to read (3 pts).

_____ : Project was insightful and carefully executed with clarity in a professional and very scientific manner (10 pts). Project was fine, they did a good job (8 pts), Project lacked context, missing interesting analyses, executed adequately, but could have done much more (6 pts). Poor job, unscientific, unsupported, inadequate (3pts) Student did not understand the assignment (1)

_____ : All Statements and reasoning were well supported and properly defined, at least 6 scientific references (10pts) They supported most of their statements, but still had some unsupported statements of fact, (8 pts), background research mostly (>50%) from unscientific sources (6 pts), Statements were unsupported by scientific citations, statements were vague, reasoning was fairly logical (4 pts), no support or context for their work (3pts)

- **Title Authorship and affiliation**: Is the title short and descriptive? Authorship should include all three authors, but the person writing the paper should be first author.

_____ Abstract:
- Short description / summary of your project (about 200 words).
- Captures the main idea of the paper.
- Discusses the most important discoveries in the paper.
- Uses important keywords.
- Concisely presented in a scientific manner.

Contains **ALL** key ideas above (10 pts), **MOST** of the key ideas above (7pts), **HALF** of the key ideas above (5pts), **NONE** of the above (1pt)

Comments

_____ Introduction:
- Clear description of the nature of the problem (what issue(s) is (are) the paper addressing?).
- Explanation as to why your study is interesting and significant.
- Scientific background information is provided about this research and to place this work within the body of similar work done by others.
- Explicit statement of research question
- Proper use of citations within the text.
- No excessive use of quoted material (should be in own words… with citations)

Contains **ALL** key ideas above (15 pts), **MOST** of the key ideas above (11pts), **HALF** of the key ideas above (8pts), **NONE** of the above (1pt)

Comments
Methods:
- They are explicit and thorough, so that the reader would be able to replicate this experiment with new subjects.
- Although thorough, the methods do not include irrelevant details.
- Clear explanation of how subjects/experimental units are randomized, replicated, treatment structure, response structure etc..
- Includes relevant information on study location population and/or species of interest.
- Includes clear plan for data analysis.
- Methods are in narrative format.
- Methods are written in past-tense.
Contains ALL key ideas above (10 pts), MOST of the key ideas above (7pts), HALF of the key ideas above (5pts), NONE of the above (1pt).
Comments

Results:
- Graphs and tables must be titled with numerically sequenced tags, e.g. Figure 1, Figure 2, with clear and descriptive figure captions.
- Figures are all well labeled; all axes are labeled and legible. Where appropriate (where there is replication), error bars (st.dev) are used.
- ALL figures must be referenced within the narrative document -- no figure orphans!
- Uses quantitative (numerical) terms in the narrative section to DESCRIBES THE PATTERN of what is presented in graphical or tabular form, connects results together and points out trends.
- Patterns supported with appropriate statistics and analyses.
- Results presented clearly without interpretation, though areas of uncertainty should be pointed out.
Contains ALL key ideas above (15 pts), MOST of the key ideas above (11pts), HALF of the key ideas above (8pts), NONE of the above (1pt).
Comments

Discussion:
- Summarized most important results and patterns.
- Scientific evaluation and analysis of the results… what do the results mean?
- Related results to the problems introduced in the introduction.
- Results placed in context of a summary of other relevant studies (with Citations).
- Discussion of the real-world significance of the results… did they corroborate or deviate from the expected patterns?
- No unsupported claims.
- Makes specific recommendations of further work.
- Some generalization to the big picture without being overly speculative.
Contains ALL key ideas above (15 pts), MOST of the key ideas above (11pts), HALF of the key ideas above (8pts), NONE of the above (1pt).
Comments

References:
At the end of the paper, 6 references cited in the text of the report are listed (usually alphabetically) with full and consistent citations (5 pts), Contains extraneous information, such as irrelevant web information (3).
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Project II  RUBRIC ORAL PRESENTATION

_____/5 pts  Descriptive title and authorship

_____/5 pts Outline/abstract:  clear description of what will be presented
10 pts perfectly executed containing all relevant points clearly presented, 7 pts: contained most relevant points, lacks some clear examples or clear, quantitative language, 3 pts: inadequate, 0 pts: not included

_____/10  Introduction:  broad description of the problem, explained why it is generally interesting.

_____/10  Background:  background research with appropriate academic citations that clearly ties in and gives interesting context for the problem

_____/10 Hypotheses:  clear statement and predictions

_____/10 Methods:  explicit description, thorough enough to allow the class to understand how the experiment was conducted, clear description of experimental design.

_____/10 Results:  Presentation of results, includes graphs and basic tables that are clearly and quantitatively discussed.  Includes proper application and discussion of statistical analyses.

_____/10 Discussion and evaluation:  Summary of the most important results and patterns and a scientific evaluation of the results... what does your study mean?

_____/10 Context:  Results placed in the context of other studies (with references).  Clear and direct comparisons made between study conducted and other work.  Uses quantitative terms when discussing other work.

_____/10 Further work and Big Picture:  Specific and logical next steps and generalization about how your work contributes to the big picture without being overly speculative

Informative and professional (5 pts), Well paced, within time limits, and readable (5 pts)

100 pts total

A note on slide readability:
Use strongly contrasting colors
Avoid fonts with Serifs.
Do not use a font smaller than 14pt, preferably closer to 20-30pt.
Use fancy animation and fonts sparingly, it can be distracting
Graphs and images/schematics can be worth a thousand written words!
Do not use the slides as a script, bullet point main ideas (3-5 words).

PRACTICE, all together, out- loud, with a timer.