Fall 2018       PHYS 1101: First-Year Seminar Physics:

Critical Thinking through Science and Science Fiction

General Information

Instructor:        Mike Brotherton       Office:       217 PS       E-mail:       mbrother@uwyo.edu

Office hours: PS217, TR 2:40-4 pm or by (e-mail) appointment

Lecture/Discussion: TR      1:20-2:35 pm     Enzi STEM Building 195


The course is taught in seminar style. You will have to read specified text ahead of lecture to be able to participate in the discussion. Not all parts of the book will be used in class, and there will be additional reading materials online, other books I make available, or from your own research.

Webpage: The class has a webpage on wyocourses.

Course Content:

The course investigates critical thinking, and how conclusions generated by science differs from that of others (e.g., courts, debates, or by journalism). Intellectual integrity is the coin of the realm of science, and the course will emphasize the importance getting to the right answer, even if contrary to preconceptions or personal biases. Furthermore, the course will explore the issues of human thinking, from logical fallacies to various cognitive biases, and how to recognize them in others and ourselves. Often people make their decisions based on other concerns rather than intellectual objectivity.

The general approach of the course will be, after establishing a foundation in critical thinking and research, to examine a number of case studies. These will start with what are relatively straightforward questions (e.g., Is the Earth Flat? Were the Moon Landings hoaxed?) to those that attract controversy, and serve as a starting point to develop research and critical thinking skills. The topics will become less clear cut as the semester progresses and be expanded in scope (e.g., critically examining the logical consequences of superpowers, critically viewing the science of scenes from science fiction movies, critically reading popular articles reporting science results).

The mid-term individual writing project will involve a critical assessment of the classic scientific revolution away from the Ptolemaic picture of the solar system to the
Heliocentric model. This is a well studied case where there are lots of sources of information in general agreement on many points.

The final writing project will be team-based (like much of science), and will involve a critical assessment of a current scientific controversy with conflicting information available: global warming. This project will also be peer reviewed by your classmates before submitting a final draft.

The specific course content encompasses a range of topics, from traditional science to science fiction to pseudoscience, as well as related real-world issues. This course is about learning some science and scientific thinking, as well as how to think critically in general in the world at large.

First-Year Seminar specifics:

This course is a first-year seminar (FYS). There are no pre-requisites. You cannot withdraw from a first-year seminar without joint approval from your advisor and instructor.

So what’s the point? A FYS doesn’t contribute to a particular major. Why should you commit to taking this course seriously? Well, FYS courses are all about learning a number of critically important skills that apply to college-level work, nearly any major, and life more generally. Critical thinking in particular, the focus of this FYS, is invaluable and in short supply in the world today. Mastering this general skill is worth more than the content from any single major course in the grand scheme of things, and you’re unlikely to see another course focused as this one is.

The course meets the six Critical & Creative thinking learning outcomes for a FYS:

1. Access diverse information through focused research, active discussion, and collaboration with peers.
   - Students learn how to read a text and how to search for reliable sources from various locations.
   - Students work together as teams for their final project, as well as critically review each other’s work prior to submission as an exercise in peer review.
   - Active discussion is a part of essentially every class meeting

2. Separate facts from inferences and relevant from irrelevant information, and explain the limitations of information.
   - Students explore the difference between data, facts, opinions, and other evidence and the inferences drawn from them in the context of various course topics.
   - Students write letters to themselves at the start and end of the course, wherein they articulate their beliefs about the reliability of information from different sources (e.g., from friends to textbooks to the internet).
3. Evaluate the credibility, accuracy, and reliability of conclusions drawn from information.
   - In the context of science, students learn the difference between hypotheses developed from considering phenomena, and testing hypotheses using subsequent experiments.
   - Many of the case studies will be tested by inter-comparing and evaluating different sources of information for well-established phenomena that are as close to fact as science gets. These experiences will form a learning set for case studies where the conclusions are less well established.

4. Recognize and synthesize multiple perspectives to develop innovative viewpoints.
   - The Final Project is a team effort that is also peer reviewed and based on diverse sources of information to reach a nuanced viewpoint on global warming.
   - Students challenge the logical fallacy of the false dichotomy in several contexts (e.g., proving a negative, coming to a conclusion in the case of insufficient data), e.g., UFOs, and psychic powers. Science is not about proof, but evidence and testing, leading to qualified positions that can be subject to change given new information.

5. Analyze one's own and others’ assumptions and evaluate the relevance of contexts when presenting a position.
   - Students, as a step in their final projects, must constructively but critically evaluate the work of other teams, and learn how skepticism can be used in a positive manner.
   - Students working on teams for their final project must work together collaboratively to evaluate and synthesize different information that each finds in their research.

6. Communicate ideas in writing using appropriate documentation.
   - While there will be smaller writing projects, the midterm and final writing projects will be the most substantial and require clear communication as well as the citation of sources used.

Teaching the Research Process

In this course you will complete two major writing projects: explaining the scientific revolution leading to the heliocentric view of the solar system, and critically examining the evidence for global warming and its causes. In order to be ready for this, you will have to do extensive research. Research will also be necessary for other assignments in this course (see syllabus), in fact research will be an ongoing activity, something that will be helpful not just in college classes but also in life.

In order to prepare you for doing research, several short but important lessons are set aside in the early weeks of the class that will include how to find different sources of information and how to evaluate them. This will include everything to asking people to the library to the internet. Books, newspapers, magazines, and scientific journals have different standards, but are not the only sources of reliable information. We will also investigate generating first-hand knowledge by doing our own in-class experiments, for example, on psychic powers.
We will learn methods to discern and choose papers from these magazines that are suitable for our subject and our level of understanding, and we will learn how to extract knowledge and facts from these sources and how to cite and quote them correctly.

For your mid-term and final projects you will put all these techniques together and work in part alone and in part in group or peer review settings to produce strong final projects.

This course follows a teaching philosophy of active and inter-active learning. You will be expected to read text passages ahead of time and you will be trained how to do so effectively. Class time will build on this reading (i.e. will not generally repeat its content) and you will often go from lecture to group work, including discussion, research, and comparison of complex arguments between groups. There are significant writing and IT components to the successful completion of the course!

**All of the following information is tentative and I reserve the right to change any of it as seems necessary to keep the class average on course. Such changes will be announced in class.**

**Lecture**  
Two lecture/discussion/research sessions per week, each 75 minutes. Attendance is generally required, and skipping class may affect your grade.

**Homework**  
The HW is due at deadlines specified in the schedule below unless cleared by the instructor in advance. Late submissions without advance notice will not be accepted in general, unless there is a university excuse or a valid doctor’s note.

HW tasks may include written summaries of hand-outs and text reading assignments or discussion questions regarding the same material. Hand-outs are provided during lecture or online. If you miss a lecture, which provides students with a hand-out, it is your responsibility to make sure you learn about the existence of the hand-out and to collect it from me in good time before the related work is due.

All hw to be delivered as instructed via wyocourses or emailed to mbrother@uwyo.edu by 11:59pm on the due day. All hw to be submitted in pdf or MS Word format.
Each task will have a unique mix of the grading categories you find below. Use the categories as a guide to get an idea what I will be looking for when I’ll grade your assignments and evaluate your contributions to discussion.

**Writing Rubric for major assignments and their categories:**

*Development of the point of view*
- A – effective and insightful, appropriate reasoning and supporting evidence
- B – appropriate reasoning but lacking some evidence
- C – vague or insufficient reasoning
- D – deficient
- F – non-existent

*Organization*
- A – highly focused, perfectly organized, coherent progression of ideas
- B – generally organized and focused
- C – some problems with progression of ideas, but present
- D – disorganized
- F – disorganized to the point of incoherence

*Use of Language*
- A -- full mastery of jargon and language metrics
- B -- appropriate use of jargon, some lack of language metrics
- C -- displays little facility of language metrics and/or mistakes in jargon
- D -- frequent fundamental language errors and grave misunderstanding of jargon
- F -- displays permanently language errors, no concept of jargon

*Figures and Examples*
- A – clearly appropriate and insightful, no formal mistakes
- B – appropriate, perhaps small mistakes in presentation
- C – a valiant attempt in the right direction, but flawed in one or more ways
- D – wrong or inappropriate
- F – absent but needed

**Grading Key** I usually underline a passage and may accompany it with a symbol that explains my thinking:

- √ correct
- ~ somewhat correct
- ≈ vague
- # wrong
- (/) misses the point, off topic
- 😞 original, imaginative, good illustration
- :-o sloppy, much too short
- ∨ repetitive, wordy
- ? confused or logic cannot be followed or lack of focus
Discussion Rubric

All students are expected to regularly contribute thoughtful commentary to discussion, both when the entire class is discussing a topic, as well as within smaller break-out groups. Each student will be evaluated several times during the semester but not every class, and will be informed if their effort is substandard early enough to make improvements.

There are three main criteria for evaluating individual contributions to discussion:

**Quality:** Superior quality (5 points) means that comments are insightful, responsive to the preceding discussion, and reflect a command of the topic. Intermediate quality (3 points) reflects a lack of preparation or an irrelevancy to the preceding discussion. Unsatisfactory quality (0 points) means that comments are factually incorrect and/or detract from the discussion.

**Impact:** Superior impact (5 points) means that comments frequently help the class or group secure understanding and advance to the next step. Intermediate impact (3 points) means that comments might move the discussion forward, but typically do not. Unsatisfactory impact (0 points) means that comments do not advance the discussion, or are actively harmful.

**Frequency:** Superior commenters (5 points) are among those most actively engaged in discussion. Intermediate commenters (3 points) are average in their frequency of commenting. Unsatisfactory commenters (0 points) rarely or never speak.

A 13+ points  
B 9-13 points  
C 5-9 points  
D 3-5 points  
F < 3 points

Communication with the students

I will make announcements in class when changes are made to the schedule. It is the student’s duty to catch up with such news, if the student misses class. That is still true, if there is a valid university or other excuse for the student absence. On occasion, I may send an email to the class. It is
the student’s duty to check their university email account in a timely manner to benefit from such information.

**Grades**

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<thead>
<tr>
<th>Assignment</th>
<th>Weightage</th>
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<tr>
<td>Discussion contribution, letter to self, etc.:</td>
<td>misc.</td>
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<tr>
<td>Research documentation:</td>
<td>misc.</td>
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<tr>
<td>Midterm Project I</td>
<td>1</td>
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<tr>
<td>Draft Final Project/Peer Review</td>
<td>1</td>
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<tr>
<td>Final project Revised</td>
<td>1</td>
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**Scale:**

<table>
<thead>
<tr>
<th>Grade</th>
<th>GPA</th>
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<tbody>
<tr>
<td>A</td>
<td>4.0</td>
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<tr>
<td>B</td>
<td>3.0</td>
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<tr>
<td>C</td>
<td>2.0</td>
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<tr>
<td>D</td>
<td>1.0</td>
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<tr>
<td>F</td>
<td>0.0</td>
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**Academic Honesty** Don’t cheat. In the long run you are only hurting your chances at succeeding at college and in the major. The actual university rules:

“Academic dishonesty is defined in University Regulation 802, Revision 2 as “an act attempted or performed which misrepresents one’s involvement in an academic task in any way, or permits another student to misrepresent the latter’s involvement in an academic task by assisting the misrepresentation.”

There is a well-defined procedure in place to judge such cases and serious penalties may be assessed. A short common sense interpretation of the regulation could sound something like this: If it’s not your work, don’t pretend that it is.

One point we will deal with here is possible plagiarism. Don’t cut and paste. Don’t claim the work of others as your own. Cite appropriately.

**Special accommodations**

If you have a physical, learning, or psychological disability and require accommodations, please let me know as soon as possible. I will try to accommodate your condition as best as circumstances allow. You will need to register with University Disability Support Services (UDSS) in SEO, room 330 Knight Hall, 766-6189, TTY: 766-3073. If you choose to notify me late about such circumstances you forfeit your right for special accommodation for that instance.

**Additional help**

The special nature of First Year Seminars can make getting additional help difficult. You are always welcome to come to office hours or make special appointments to discuss your ideas and to ask questions with/of your instructor. In addition, group work is allowed during the planning stage of an assignment, and even required for the final project. Be encouraged to continue discussions with your classmates outside of class!
About Me
I am an observational astronomer specializing in the study of quasars and other types of active galaxies powered by super-massive black holes. I have B. S. degrees in electrical engineering and space physics from Rice University in Houston, TX. I received my PhD in astronomy from the University of Texas at Austin and have previously worked at Lawrence Livermore National Laboratory and Kitt Peak National Observatory. I've really used the Very Large Array (the "VLA", a radio telescope in New Mexico featured in the movie Contact), the Hubble Space Telescope, the Chandra X-ray Observatory, and many other facilities. I'm also a science fiction writer with two novels (Star Dragon, Spider Star) and several short stories professionally published. I also recently edited an anthology of short stories Science Fiction by Scientists.
Class Schedule Fall 2018, PHYS 1101, Instructor: Brotherton
“Critical Thinking through Science and Science Fiction”
Classes meet Tuesdays and Thursdays 1:20-2:35pm, ENZI 195
Some additional assignments given in class or on wyocourses

<table>
<thead>
<tr>
<th>Week</th>
<th>Tuesday</th>
<th>Thursday</th>
<th>Text Reading and Guide</th>
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<tbody>
<tr>
<td>1</td>
<td>N/A</td>
<td>Intro, Syllabus</td>
<td>Lack&amp;Rousseau Ch.1</td>
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<td></td>
<td>8/28</td>
<td>8/30</td>
<td>Skepticism/Belief</td>
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<td>Questionnaire</td>
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<td>2</td>
<td>Science, Ways of Knowing</td>
<td>What is Critical Thinking?</td>
<td>Lack&amp;Rousseau Ch.2-4</td>
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<td></td>
<td>9/4</td>
<td>9/6</td>
<td>Letter to self re: Info Sources</td>
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<td>3</td>
<td>Dava Newman visit NASA Telling the Truth?</td>
<td>Human Biases and Logical Fallacies Eval Info Sources?</td>
<td>Lack&amp;Rousseau Ch. 5-6</td>
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<td>9/11</td>
<td>9/13</td>
<td>Online test: How reliable is your knowledge?</td>
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<td>4</td>
<td>Case Study: A Flat Earth</td>
<td>Case Study: Moon Landing Hoax? Or Astrology?</td>
<td>Prep. Research for case studies</td>
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<td>9/18</td>
<td>9/20</td>
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<td>5</td>
<td>Numeric Estimation: Fermi Paradox, Aliens</td>
<td>Case Study: UFOs</td>
<td>Lack&amp;Rousseau Ch. 7</td>
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<td>9/25</td>
<td>9/27</td>
<td>Prep. Research for case study</td>
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<tr>
<td>6</td>
<td>Logical Extrapolation: Superpowers</td>
<td>Case Study: Psychic Powers Meet Science</td>
<td>Lack&amp;Rousseau Ch. 8</td>
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<td></td>
<td>10/2</td>
<td>10/4</td>
<td>Prep. Research for case study</td>
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<tr>
<td>7</td>
<td>Being Critical: SF Movies 1</td>
<td>Being Critical: SF Movies 2</td>
<td>Movie Scene Hunt</td>
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<td>10/9</td>
<td>10/11</td>
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<td>8</td>
<td>Paradigm Shifts</td>
<td>Heliocentrism</td>
<td>Supplemental Reading</td>
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<td>10/16</td>
<td>10/18</td>
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<tr>
<td>9</td>
<td>Science Controversy Trial of Galileo</td>
<td>Discussion: Heliocentrism</td>
<td>Supplemental Reading</td>
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<td>10/23</td>
<td>10/25</td>
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10  OK Not to Know
Intellectual Integrity
Questions of Existence
10/30

Truth, Belief, and
and evidence. Case
Study: Cryptozoology
11/1

Midterm Paper Due 10/31

11  Being Critical of
Skeptics, Lack &
Rousseau
11/6

Global Warming and
modern science
controversy
11/8

Reviewing our textbook
Final Team Project Assigned

12  Jeffrey Bennett visit
Climate Change
11/13

Critiquing Science
Journalism
11/15

Reporting Research

13  The Sokal Hoax and
the “Culture Wars”
Science and Postmodernism
Fake Science Journals
11/22
11/24

Thanksgiving
draft Final Reports due T
11/22

14  Peer Review in Science
Science standards
11/27
11/29

Peer review reports due Th
11/29

15  Discussion of course
Final project
Letters to self
12/4
12/6

Discussion of Final
Project, Case Study:
Students’ choice

Final reports due
Midterm Project:
Individual paper: What was the Greek view of the solar system? What evidence supported the Ptolemaic paradigm? Why did some people challenge that paradigm? What evidence was there to change the paradigm to the Heliocentric model? Why did some people challenge the new perspective? How did the situation eventually turn out? Illustrate with figures as appropriate and cite your sources.

Final Project:
Team paper: What is the evidence that average surface temperatures of the Earth are increasing? What is the quality of the evidence? What are proposed causes of the temperature increase? What is the evidence for and against each one, and the quality of that evidence? Please illustrate with figures as appropriate and cite your sources. Please also provide a statement about the contributions of each team member. Be aware that this project will be done in two steps, an initial submission for peer review, and a revised version after a peer review.

These projects will be graded with a view to the logical development of ideas and supporting evidence, along with references and evidence of independent research. More explicit and detailed versions of these assignments will be given in class.