Supplemental Material

CBE—Life Sciences Education

Rowe *et al.*

SUPPLEMENTAL MATERIAL

1. Expanded Course Rationale and Structure

Jon D. Miller, the Director of the International Center for the Advancement of Scientific Literacy, wrote, "the healthy functioning of democracy depends crucially upon the existence of a literate public; and in modern industrial societies, true democracy must embrace scientific literacy (Miller, 1998). We share this concern, as the lack of scientific literacy adversely affects our ability, as a society, to make informed decisions about science-related issues (Impey et al., 2012) such as global climate change, loss of biodiversity, resource use, and the efficacy of vaccines. And, as discussed in the main article, this situation also makes it difficult for people to judge the merits of well-established scientific theories, including the Theory of Evolution and the Big Bang Theory.

In order to address these issues, the Foundations of Science (FoS) course was designed to focus on the development of critical thinking skills and basic scientific literacy defined – consistent with Miller's definition – as understanding key scientific terminology, concepts, and theories and, most importantly, understanding science as a reliable way of knowing about the natural world based on its use of critical thinking and logical arguments, empirical evidence, skepticism, the scientific method, objectivity/intellectual honesty, and peer review. This approach, as well as other aspects of the course design discussed below, is also consistent with the recommendations put forward by the AAAS in its Project 2061 (American Association for the Advancement of Science, 1993; Rutherford and Ahlgren, 1990), which was developed to establish recommendations for science literacy in the U.S.

Nature of Science

Part of the rationale for developing an integrated science course, and one which addresses science as a way of knowing, was the recognition that, if students take only two required science courses in college, they will necessarily graduate with gaping holes in their knowledge of science because they will have learned little or nothing of the key ideas in the science disciplines that were not included in their coursework.

In addition, because undergraduate science courses typically do not address the nature of science and scientific reasoning, students will not develop an understanding of the rationale for the scientific method *as a means of reducing or eliminating error*, nor will they develop their scientific reasoning skills and their ability to apply them to real-world situations. Nor will they will be able to distinguish good science from 'bad' science, or real science from pseudoscience.

The fact that most Gen-Ed science courses do not address these concepts leaves graduates unprepared to make informed decisions regarding science-related issues, and it makes it far more likely they will reject well-supported theories in science. As evidenced by the

rise of an anti-vaccine 'movement' in the U.S. and elsewhere, they may also reject the well-established efficacy of vaccines and the health benefits afforded by them. Lacking an understanding of the scientific methods by which medicines are tested for safety and efficacy, and placing higher confidence in anecdotal accounts, many people abandon thoroughly researched medical practices and treatments in favor of untested and even harmful 'alternative medicines' and practices. In short, there are numerous indicators that people are implicitly rejecting the validity of the scientific method itself. This anti-science attitude has profoundly negative implications and consequences for society as shown by the outbreak of whooping cough in the U.S. in 2012. More than 11,000 cases were reported to the CDC, at least 12 of which were fatal. This was the largest number of cases reported in the last 50 years (Rosenau, 2012). This outbreak of an entirely preventable disease occurred because parents rejected the scientific basis of vaccines and chose not to have their children vaccinated.

The critical thinking/scientific-reasoning framework of the course is encapsulated, as we discussed in the paper, in a set of questions Bernstein et al. (2006) suggest be asked when evaluating a claim. James Lett (1990) expanded those questions into a more formalized set of rules known by the acronym FiLCHeRS, a framework we find particularly useful for helping students distinguish science from pseudoscience. The easily assimilated acronym (once students understand what it means to be *filched*) stands for Falsifiability, Logic, Comprehensiveness of evidence, Honesty (as in 'intellectual honesty'), Replication of research, and Sufficiency of evidence, respectively. Every claim and theory in the course, both scientific and pseudoscientific, is evaluated using Lett's rules. Our repeated use of the framework provides students with a systematic, coherent method for analyzing claims. They quickly learn to spot pseudoscientific claims because such claims violate many of the rules, while good scientific claims do not. In short, Lett's framework provides a compelling demonstration of the reliability of the scientific method. Step-by-incremental step, we try to expand the students' latitudes of acceptance (see sections on SJT in the main manuscript and also below) by helping them understand the power of science as a way of knowing.

Critical Thinking

In order to think critically, the student must first know what critical thinking is and value it as an essential component of informed decision-making. They also must understand at least some of the ways in which critical thinking can be subverted based on biases, misperceptions, faulty memory, and cognitive dissonance so that they can avoid these sources of error. For this reason, the lecture and lab include discussions and activities that directly demonstrate limits in the accuracy of our students' own perceptions and memories. These activities are not only engaging, but they vividly demonstrate the unreliability of anecdotal testimony and, by inference, the need for the scientific method.

Ultimately, any hypothesis or theory in science is based on an argument; therefore, it is essential for students to understand the structure of an argument (premises and conclusion), the characteristics of a valid and sound deductive argument, and the

characteristics of a reasonable, or sound, inductive argument. Therefore, as discussed in the main article, we do something that is unique in a science course, but which is fundamentally important to the success of the course; namely, we include a discussion of arguments, as well as common heuristics and logical fallacies. Very few college students are aware of what an argument is, or of heuristics and fallacies, prior to taking the course, and few students would be exposed to them outside of a philosophy course; yet, an understanding and awareness of them is essential to critical thinking and to the evaluation of claims. Because the reliability of science as a way of knowing rests to a large degree on the arguments it makes, students must understand what constitutes a good argument; i.e., they must understand the necessity of having good reasons for either accepting or rejecting a claim, which is based on an argument.

An example of this is provided by the argument we use to establish the multi-billion year age of the universe. This argument is discussed in the section of the course dealing with astronomy and the Big Bang Theory.

1) Premise 1: We can see galaxies located more than 13 billion light years away.
2) Premise 2: By definition, it takes light one year to travel a distance of one-light year.
3) Conclusion: The universe must be at least 13 billion years old in order for light to have reached us from galaxies located 13 billion lights years away.

Our students, having learned about arguments, can now recognize this is a valid and sound argument, and so it is reasonable for them to conclude that the universe really is billions of years old. Had they not learned about arguments, this conclusion might otherwise carry little weight and its conclusion be dismissed as mere opinion.

Pseudoscience

One of the most important aspects of the course is that students are asked to use what they have learned in the course, both scientific facts and critical thinking concepts, to evaluate a variety of unsupported and/or pseudoscientific claims. The need to include such extraordinary claims derives from the readily observable fact that the media bombards people with such claims on a daily basis – yet most people, including college graduates, lack the scientific knowledge and critical thinking skills to evaluate them (Johnson and Pigliucci, 2004). Consequently, many people uncritically accept them, as happened recently when the *Animal Planet* channel ran two pseudo-documentaries on the alleged existence of mermaids. The second documentary was the most watched show in the history of the channel, with about 3.6 million viewers (Day, 2013). By incorporating pseudoscientific and extraordinary claims into the course, and using scientific facts, laws of nature, and critical thinking skills taught in the course, students gain real-world experience in using this information to rationally evaluate claims – and they learn science in the process. This is consistent with an approach advocated by Martin (1994) who argued that science teachers should include pseudoscience in their courses, not for purposes of teaching it, but to help students learn to distinguish science from

pseudoscience and to critically evaluate claims. Were students taught science in this manner, and armed with critical thinking skills as part of their science education, few would fall for the sorts of claims presented in the mermaid pseudo-documentary – or for a host of other pseudoscientific claims that permeate our culture.

The evaluation of the pseudoscientific claim regarding the Loch Ness monster (Rowe, 2015) was mentioned in the main article. Another example concerns the evaluation of claims pertaining to astrology which, according to SEI 2014 (National Science Foundation, 2014), 42% of Americans believe is either "sort of scientific" (32%) or "very scientific (10%). Prior to the discussion of this topic, students first learn relevant astronomy pertaining to stars, galaxies, and interstellar distances. They also learn about the four fundamental forces of nature. Using this information, students can then begin to evaluate the claim that a mere 200 stars, out of about 200 billion in our galaxy, somehow exert – through means that defy scientific understanding of the universe – an effect on the personalities of people and their lives based on the position of these stars (and planets) at the time of their birth. By learning about the fundamental forces of nature (of which there are only four and no more), students realize that the strong and weak nuclear forces could not exert such an effect because their range is limited to the nucleus of an atom, and that both the gravitational and electromagnetic force are too weak – at those distances – to produce a biological effect. Indeed, they calculate that the doctor standing next to a mother at the time of her child's birth exerts a gravitational force millions of times greater than does the nearest star. And, even if these two forces do have the ability to 'reach' a person, students are asked to consider the related question of how, exactly, it would affect personality and/or control a person's future? What is the proposed mechanism? As students learn in the course, pseudoscience never offers a plausible, observable, or testable mechanism to explain how alleged extraordinary or paranormal phenomena are supposed to occur. In contrast, scientific explanations require that such a mechanism be offered.

Critical Thinking and Psychological Factors Affecting the Acceptance of Ideas

Students also learn relevant psychology pertaining to the reasons why people may believe astrology and other extraordinary claims are true even when there is no objective evidence for them. In the case of astrology, the specific psychological factor that is addressed is the Forer Effect (also called the Barnum Effect); i.e., the tendency of people to think a general statement which applies to most anyone (such as that in a horoscope) appears to apply exclusively to them. This combination of knowledge and analysis enables students to understand that astrology is pseudoscience, but in the process of discussing astrology, they learn about astronomy and physics, as well as relevant psychological factors which influence our perceptions. In a similar manner, students use the laws of nature and relevant psychology to evaluate claims about UFOs, alien abductions, ghosts, and paranormal phenomena. In the process, they learn how easy it is to misperceive events, or fall victim to critical-thinking pitfalls such as selective recall and confirmation bias, and thereby incorrectly conclude that something is true when it is not.

It is important to emphasize that, as instructors, we do not – acting as 'experts' – tell our students that the Loch Ness monster, or astrology, or any other claim in the course is wrong; nor do we tell them that a scientific theory is 'correct' and that they should simply accept it because "we say so." We let them judge the claims and theories for themselves based on the evidence, relevant science, and critical thinking skills they have learned. This 'compare and contrast' approach reduces the likelihood of an automatic rejection of a scientific explanation by eliminating the human tendency to reject an idea because it was presented in such a way as to imply that the students' freedom of choice is being taken away from them; as in, "Don't try to tell me what to think" (Erwin, 2014). Furthermore, evidence regarding some extraordinary claims is ambiguous and may yet prove to be true. In such cases, this is acknowledged and it reinforces the fact that not everything is clear-cut. We stress that science is a process of acquiring knowledge, and much has yet to be learned. Just as importantly, we stress throughout the course that the truth of an idea is not determined by whether we like it, or how many people believe it, but by the quality of evidence and logic used to support it (the S and L in the FiLCHeRS acronym). Our results show that this approach is successful in teaching students the effectiveness of the scientific method and critical thinking in evaluating claims, and in distinguishing science from pseudoscience.

In developing the course, we recognized that an appreciation of critical thinking and acceptance of science and scientific theories involves far more than a student's exposure to scientific facts and the scientific method. Perhaps more importantly, it also involves their worldview; i.e., their beliefs and attitudes toward science. These affect their psychological readiness to examine various scientific theories and to engage in critical thinking (Alters and Nelson, 2002). Especially as regards the Big Bang Theory and the Theory of Evolution, students' prior beliefs may prevent them from even considering the possibility that these theories might be correct because the ideas are perceived as a threat to their religious worldview. Failure to address this fundamentally important psychological component of students' thinking will almost inevitably result in a failure to convince students that these ideas are not mere opinions but, rather, well-supported theories based on empirical evidence. In short, if a scientific theory (or its implications) is too far removed from a students' current worldview, and if it is considered threatening, it will almost certainly be summarily rejected; in fact, a student may become even more convinced that it is wrong if simply presented with "the scientific facts."

Accordingly, great care must be taken when discussing controversial topics so as not to threaten the students' religious worldview (see NOMA below) or reinforce these negative perceptions. Furthermore, simply presenting the facts regarding these theories is unlikely to produce a shift in their perceptions of these theories. However, Social Justice Theory (SJT), which pertains to attitude change, provides a means of addressing this psychological factor. According to this well-established theory, which is based on what are termed *latitudes of acceptance and rejection*, a position that is substantially different from a person's initial position can eventually be accepted if that person's latitude of acceptance and rejection is incrementally shifted toward the new position. Small, gradual shifts of opinion can lead to a willingness to consider once incongruent ideas (Benoit, no

date). In contrast, a single, big shift leading to the acceptance of a highly incongruent idea does not usually occur. This is why a science course dealing with these topics should include an in-depth discussion of the nature of science, critical thinking, and the benefits of science, as well as information which will be relevant to the discussion of evolution (e.g., the age of the earth and universe). This information should be discussed before evolution is discussed because it leads to gradual shifts in students' latitudes of acceptance. Attempting to discuss evolution first, without having carefully laid a foundation for it, will be unlikely to produce attitude change because it lies too far outside a student's latitude of acceptance.

Given that the Internet and airwaves are full of unfounded and pseudoscientific claims made by people lacking relevant expertise in science, our discussion of critical thinking also includes an evaluation of what constitutes an expert, especially a scientific expert (e.g., relevant degree, publication record, etc.). This is critically important because, if students cannot distinguish a reliable source of information from one that is not, they will be more likely to accept pseudoscience – and to reject real science. For example, if parents think a celebrity is a better source of information regarding the efficacy of vaccines, they might choose to not have their child vaccinated because they consider the celebrity to be more knowledgeable than a doctor or the medical establishment.

Our working assumption for teaching both scientific facts and critical thinking concepts in the same course is rather obvious; namely, if students have facts, but cannot think logically, they will reach the wrong conclusion; and, if they can think critically, but lack scientific knowledge, they will also reach the wrong conclusion. Both are necessary, and by relating the critical thinking concepts to specific scientific and pseudoscientific claims, students learn the concepts better.

Additional Information about Topics and Topical Organization

The course is organized into a sequence of topics specifically arranged so as to shift students' latitudes of acceptance and rejection in favor of science. In the main article, reference was made to the discussion, at the beginning of the course, of witch hunts and the Satanic Ritual Abuse cases as a means of demonstrating the necessity of both scientific literacy and critical thinking in order to avoid harm. In other words, the point of this discussion is to show that not only are science and critical thinking not bad things to be feared or rejected, they are actually good things to be embraced because they provide so many benefits to humanity and prevent so much harm.

One source of confusion we also address early in the course are the distinctions between a fact, hypothesis, law, and theory. Understanding the distinctions between these terms is essential because most students are confused by them (Alters and Nelson, 2002), and this confusion serves, to some degree, as the basis for rejecting anthropogenic climate change, the efficacy of vaccines, the Theory of Evolution, and the Big Bang Theory (as in, "they are only theories"). This confusion also leads students to embrace many pseudoscientific concepts because, in the minds of many, "theories are just opinions" and their own

preferred opinion is just as good as the 'misguided' opinions of scientists. The discussion of the Big Bang theory is specifically intended to illustrate these distinctions and to emphasize the nature of a scientific theory; i.e., that a theory is a well-established explanation of what is observed. Once the students understand the observations upon which the Big Bang theory is based, and the 'logic' of the theory, they are much more likely to accept it, and the multi-billion year age for the universe. The same applies to the Theory of Plate tectonics and the Theory of Evolution. We also stress that no theory is complete; i.e., that it is an approximation of reality and is subject to change based on new evidence. This idea, which is the idea that science, unlike other ways of knowing/thinking, is self-correcting, is stressed throughout the course.

Beginning with the discussion on astronomy, we make a concerted effort to inculcate a sense of awe in our students – a sense of the grandeur and wonder of the universe as revealed by science. This, we hope, further helps students embrace science as a way of knowing. In short, if science is seen as a source of beauty and wonder, rather than as a boring, cold, heartless endeavor that diminishes a sense of wonder, students are more likely to engage science. Many students, for example, develop an appreciation for cosmology once they understand that they really, truly are made of stardust. How wonderful.

In the second part of the course, we introduce students to the experimental method. This includes such concepts as independent and dependent variables, confounding variables, placebo effects, control groups, experimental groups, double-blind studies, experimenter bias, and sample size. The emphasis, as always, is on sources of potential error and how the scientific method attempts to control for them. We emphasize, either implicitly or explicitly, that the procedures embedded in the scientific method for reducing and eliminating error are what makes science "a good thing" – something to be appreciated rather than rejected.

These concepts are reinforced through a discussion of the FDA approval process, followed by discussions and analyses of various complementary and alternative medicines, such as homeopathy and therapeutic touch. As regards these two "therapies," students have learned enough at this point in the course to realize they clearly violate the laws of nature, and any anecdotal evidence of their efficacy is due to a placebo effect, spontaneous remission, misdiagnosis, etc. Knowing this enables students to draw the conclusion that homeopathy and therapeutic touch are examples of pseudoscience. Just as importantly, they learn that CAM claims in general are virtually never tested or evaluated. Understanding this reinforces the efficacy of science and leads to healthy skepticism of CAM claims in general.

Psychic research is covered following the discussion of CAM – again with an emphasis on the ways in which these phenomena, even if real, appear to violate our current understanding of the laws of nature. The lack of successful replication of seemingly positive results (the R in the FiLCHeRS rules) is also discussed as part of the analysis of these claims. While not definitively 'debunking' psychic phenomena, students come to understand that the scientific community has not accepted the existence of paranormal

phenomena – not because scientists are 'biased', but because the evidence is insufficient to conclude that paranormal phenomena are real (the S in the FiLCHeRS rules). Scientists also do not accept paranormal phenomena because they contradict a well-established body of knowledge in science. This principle of *non-contradiction* as a criterion of truth (i.e., the necessity of logical consistency between a claim and well-established knowledge) is stressed throughout the course.

Following the foray into CAM and paranormal phenomena, we discuss principles of geology and plate tectonics, the formation and age of the earth, rock types, relative and absolute dating techniques, uniformitarianism, and finally genetics and evolution. By providing evidence of the ancient age of the universe and earth through the discussion of astronomy and geology, students more readily accept the scientifically established age of the earth. For students who might otherwise be swayed by advocates of Young Earth Creationism, this is critical for their potential acceptance of evolution because it shows them that the earth is, in fact, ancient in age, having existed for the vast amount of time required for biological evolution to have occurred (Smith, 2010a, b).

Furthermore, by continually demonstrating the reliability of science as a way of knowing throughout the course, and specifically contrasting Creationism/Intelligent Design/Irreducible Complexity with the evidence for evolutionary theory, we are able to gradually shift the students' latitude of acceptance toward a willingness to accept evolution because they can see the evidence for themselves – and the logic upon which it is based.

The principle of logical consistency as a criterion for truth is particularly important in the discussion of young-earth creationism because its acceptance requires the negation of findings from astronomy, geology, paleontology, genetics, physics, and chemistry. In short, it is inconsistent with these other fields; consequently, one would have to discard virtually all of science, and the scientific method itself, in order to accept it. However, only by establishing the validity of astronomy, geology, the scientific method, etc., earlier in the course does this argument carry weight. This is why the topics are discussed in a specific sequence – and why evolution is covered last in the course. Without having laid an appropriate foundation, the discussion of evolution earlier in the course would almost certainly result in fewer students' willingness to consider it and, in accordance with Social Justice Theory, might actually lead them to reject not only the idea of evolution, but other scientific conclusions discussed in the course as well.

As with the "Age of the Universe argument," we also use an "Evolution argument" which, after having covered genetics, mutations, and the evidence of evolution, is very compelling to students. One version of the argument for evolution we use is:

1) Premise 1: Genetic change occurs; i.e., mutations occur producing new genes, new alleles, and new genotypes. (*We also stress that, contrary to popular belief, not all mutations are bad. This mistaken belief must be addressed because it necessarily precludes an acceptance of evolution.)

2) Premise 2: Genetic changes can be passed from parent to offspring (i.e., the changes are inherited from parents)
3) Premise 3: Natural selection occurs due to competition, with those genotypes/phenotypes best suited to their current environment surviving and producing more offspring
4) Conclusion: Changes in the allelic frequencies of a population necessarily occur; therefore evolution occurs.

Students accept each of the premises and, having done so, they are more likely to accept the conclusion that evolution occurs. Students recognize this as a valid and sound argument. Indeed, at this point, we flip the question from "Does evolution occur?" to, "How could it not occur?" Again, without understanding an argument, or what makes an argument valid and sound, this approach would probably not be effective; hence the need to include these concepts in a science course. Critical thinking/logic is essential to an acceptance of evolution, as was shown by a study of non-major biology students. Those who were less skilled in critical thinking were also more likely to hold nonscientific beliefs and their nonscientific views were not easily changed (Lawson and Weser, 1990).

Limitations of Science

There is one additional aspect to this process that we think is of critical importance to the observed shift in students' willingness to accept, or consider, the Big Bang Theory and the Theory of Evolution. In order to address concerns students may have that these ideas threaten their religious beliefs, which constitute a key factor leading to the rejection of scientific theories and, by implication, science itself, we adopted Stephen Jay Gould's concept of Non-Overlapping Magisteria (NOMA) (Gould, 1999). This concept is based on the idea that there are different domains of human experience and that science deals exclusively with the domain that can be empirically investigated. Science does not, by its nature, address questions of morality, or ultimate meaning or purpose, as do religion, ethics, and philosophy. Accordingly, we stress the strength of science throughout the course in terms of its ability to advance knowledge of empirical matters, but we also acknowledge its limits regarding other aspects of the human experience pertaining to meaning, purpose, and values. We also point out that the assertion one can either "be religious" *or* accept evolution, but not both, is an example of one of the fallacies they have learned; namely, the False-Dichotomy fallacy. As Joshua Rosenau of the National Center for Science Education said, "Recognizing and defusing the social pressures underlying science denial are key in convincing people that it is even worth considering scientific ideas that seem contrary to those of their social identity" (Rosenau, 2012).

Having established the distinctions between science and non-science early in the semester, and putting forward the NOMA principle, our students are more receptive to scientific theories because they do not feel threatened by them. We recognize that not all scientists share this view about NOMA and might be philosophically opposed to this approach; however, the effectiveness of our approach, which addresses the psychology of

belief and is respectful of the worldviews of our students, has been shown to be quite effective based on our results involving the MATE assessment.

Our approach is also consistent with that recommended by Smith (2010a, b) in a comprehensive review of the literature concerning philosophical and pedagogical issues regarding the teaching of evolution. He specifically addresses the need to acknowledge both students' worldview (and how it affects their willingness to consider evolution), and their misconceptions regarding science and evolution. Accordingly, he emphasizes the necessity of using pedagogical approaches based on recognition of cognitive factors affecting belief and conceptual change, as well as the need to teach the nature of science – not just the facts of science. He also argues that a NOMA-based approach is more successful in facilitating change in attitudes regarding evolution and, we would argue, would apply to the Big Bang theory and other scientific ideas students find discomforting.

Use of Case Studies and Assignments

There is one additional aspect of the course design we believe has been critical in our success; i.e., an active and cooperative learning approach built around case studies. Smith et al. (2005) reported that, between 1924 and 1997, more than 168 studies were conducted in an attempt to assess the relative effectiveness of various methods of learning, namely, cooperative, competitive, and individualistic pedagogies. A meta-analyses of these studies showed that the cooperative learning approach resulted in significant and substantial increases in learning; i.e., higher achievement, relative to either the individualistic or competitive approaches. The measures used to gauge the amount of learning included information learned, accuracy of knowledge, critical thinking/reasoning, and ability to creatively solve problems. In short, research strongly supports the conclusion that cooperative learning in its various forms is superior to lecture alone.

This same pattern was found by Springer et al.'s (1999) meta-analysis of the effectiveness of small group interactive engagement on learning by undergraduates in STEM courses. Results showed that students who worked in small groups performed at higher levels, had better attitudes, and were more likely to remain STEM majors than students in a traditional lecture class. In a similar review of the literature, Johnson, Johnson, and Smith (2007) reported that cooperative learning (which is incorporated into the case study approach used in the FoS course) tends to have several positive results which included, but were not limited to, improved learning and retention of the material, the more frequent use of critical thinking and metacognition, and improved problem solving. Based on the results of almost a century of research comparing cooperative learning with individual and competitive learning, the FoS course was designed to require active engagement and critical thinking on the part of students as they work together as members of a group to evaluate claims in lecture, in homework assignments, and in lab.

Peer Evaluation System

To ensure student engagement in group work, and a more accurate accounting of a student's participation within the group, we implemented a peer evaluation system modeled after Larry Michaelsen's Team-Based Learning approach (Parmelee et al., 2012); the system requires students to evaluate the contribution of their team members, for group-related tasks only, for purposes of determining each student's group score. The use of this type of system, which was highly recommended by faculty affiliated with the Case Study program at SUNY-Buffalo, helps alleviate students' concern that some members of the group will do all the work, but everyone – including slackers – will get the same grade.

Conclusion

Based on the assessments used to evaluate our course, the number of students assessed (475 for CAT test; 1443 for the pre-MATE assessment and 1251 for the post-MATE assessment), as well as the length of the assessment period (4-5 years), the results are robust and demonstrate the greater efficacy of the FoS course for teaching scientific reasoning/critical thinking and science literacy relative to traditional approaches to teaching General-Education science courses for non-majors. The success of the FoS course is based on the inclusion of principles of critical thinking and logical fallacies, information pertaining to the limits of perception and memory, the nature of science, and details regarding the scientific method. In addition, it specifically contrasts science with pseudoscience, and uses a case study approach requiring students to use their scientific knowledge to evaluate claims. This encourages higher order thinking and the perceived relevance of the material. Because the course deals with ideas that could potentially create dissonance in many students, it directly addresses this concept through consideration of relevant psychological factors affecting belief. Finally, the use of group work enhances learning, and the use of a peer evaluation system encourages participation of all students when doing group work.

It is this combination of approaches, which is not part of traditional science courses, that we believe has made the course successful in promoting the development of critical thinking and the acceptance of discomforting scientific theories. It has helped our students better evaluate the innumerable examples of pseudoscientific claims that permeate our society. By adopting this approach to science education, our students have a greater understanding and appreciation of science and why it works, and they are more-informed and better-prepared to make decisions than are students who complete more traditional general-education science courses.

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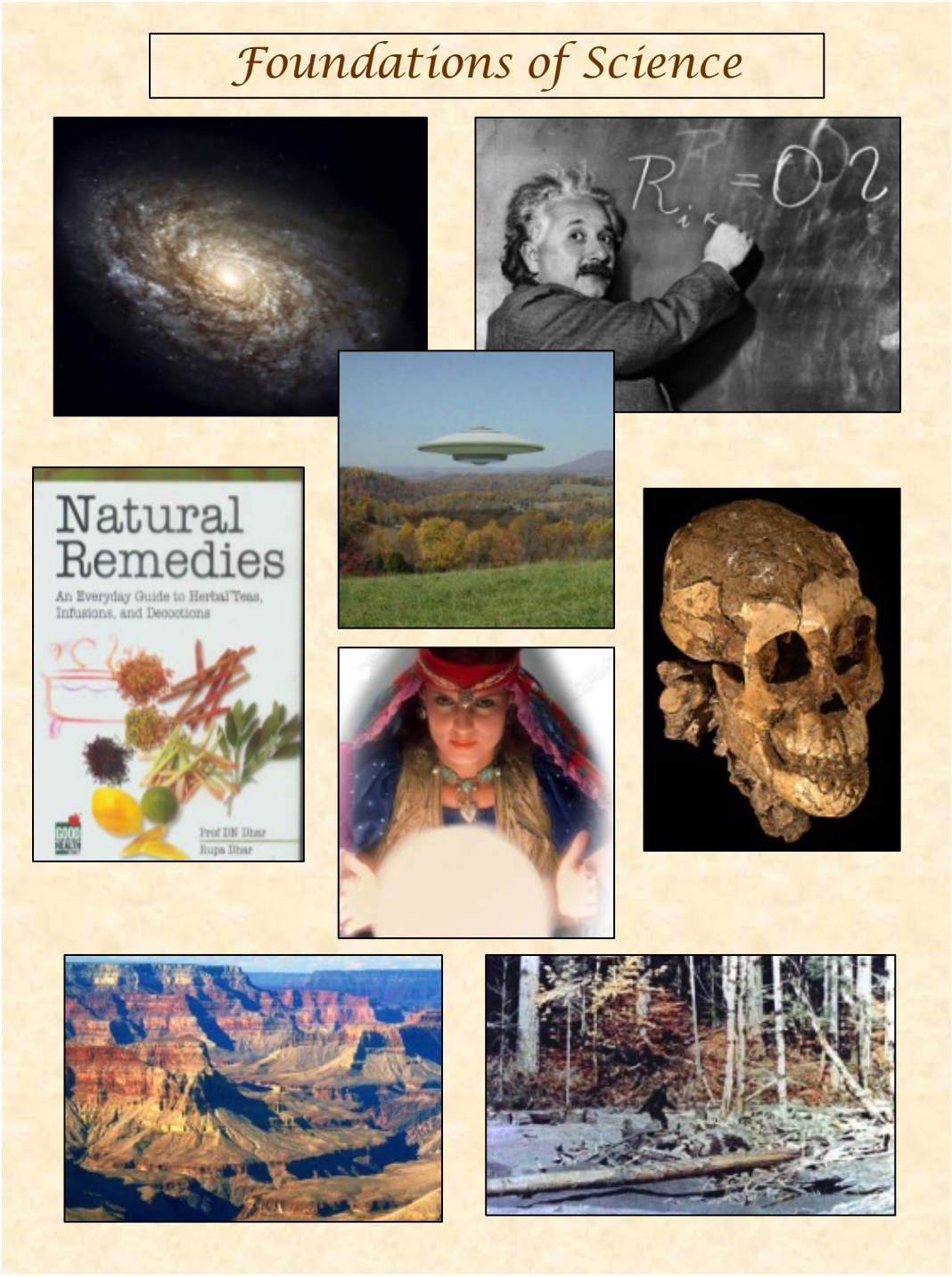
2. Example Course Syllabus



Foundations of Science

BIOL 1436-04; CRN: 23793

Spring Semester 2015

Course Number and Title: BIOL 1436-04: Foundations of Science (4 credits)

Class Time: Tuesday and Thursday (9:30-10:50)

Class Meeting Room: Lee Drain Building (LDB) 207

Name: Dr. Marcus Gillespie: Office Number: LDB 200 (Dean's Office area)

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*** I always try to have an "open-door" policy as regards office hours, so please feel free to call or come by any time that you have a question.**

Catalog Description: The course focuses on the nature of science as a reliable method of acquiring knowledge about the natural world. Students will learn how to apply key scientific facts, concepts, laws and theories to distinguish science from non-science, bad science, and psedudoscience by analyzing a variety of claims and case studies. By employing an innovative, interdisciplinary approach to science education, this course is designed to increase science literacy and critical thinking skills for introductory-level students who are not science majors. **Students MUST enroll concurrently in the corresponding lab for this course**. Credit: 4

Course Description/Rationale: The rationale for this course is to enhance your scientific literacy by making science both interesting and relevant. This will be accomplished by helping you understand how science works and how you can apply science in your daily life, especially when evaluating extraordinary/unusual claims in which almost everyone is interested – including UFOs, ESP, and mysterious creatures like Big Foot.

Accordingly, the overarching objectives of this course are to enhance your scientific literacy and critical thinking skills using an integrated, multidisciplinary approach that draws upon key concepts from the natural sciences, psychology, and critical thinking. The three broad goals of this integrated course are:

1) to enhance your understanding and appreciation of science as a proven and reliable method of comprehending the natural world, and to help you distinguish scientific from non-scientific and pseudoscientific ways of thinking about the world;

2) to provide you with a more well-rounded understanding of science by teaching you the basic principles, facts, laws, and theories from the natural sciences and, when relevant, from psychology;

3) to teach you specific rules of critical thinking so that you can use them, and your knowledge of science and the scientific method, to make more informed decisions. All three goals are inseparable and are interwoven throughout the course.

These three goals will be accomplished by using information from the natural sciences, the scientific method, and rules of critical thinking to examine a range of claims that are common in our society. These claims include, but are not limited to, extraordinary claims and pseudoscientific claims such as those pertaining to astrology, UFOs, legendary creatures, the lost continent of Atlantis, alternative medicines, paranormal phenomena, and others. Through an examination of these and other topics, as well as the evidence for key scientific theories, you will learn more about the nature of science and the scientific method, how to more reliably evaluate the veracity of claims, and how to avoid common errors in reasoning that lead to erroneous conclusions. This knowledge will help protect you from fraudulent and misleading claims and will enable you to make more informed decisions regarding issues of significance to our society. Finally, it is my hope that you will gain a greater appreciation of the beauty and wonder of the natural world as revealed by science.

Upon successful completion of the course, you will be able to:

1. Understand and apply scientific terminology pertaining to the nature and conduct of science, such as hypothesis, law, theory, control group, placebo group, confirmation bias, and double-blind study;

2. Apply methods of reasoning used by scientists: i.e., the scientific method based on the requirements of falsifiability/testability, logical consistency, comprehensiveness of evidence, intellectual honesty (objectivity), replication of results, and sufficiency of evidence;

3. Analyze and evaluate common logical fallacies and perceptual biases that interfere with the ability to draw reasonable and/or correct conclusions, as well as the difference between facts, informed opinions, and uninformed opinions;

4. Learn key concepts and theories from a variety of scientific disciplines, especially physics, biology, and geology;

5. Demonstrate how to distinguish science from pseudoscience by scientifically evaluating a wide variety of extraordinary claims that are common in our culture today.

Just as importantly, upon completion of this course, we hope that you will have a greater appreciation of the role of science in all of our lives and the need for scientific literacy and critical thinking to help make informed decisions about issues currently facing our society.

Methods of Instruction: This course is based on a combination of traditional lecture format, coupled with the use of "**case studies**" which involve classroom-based group work, class discussions, homework assignments, and readings. The use of case studies (which are stories with an educational purpose) has been shown to: significantly increase student interest, enjoyment, and involvement with a course; improve grades; and enhance students' critical thinking ability.

Students are required to take the lab concurrently because the lecture and lab constitute a single course. The lab is also based on the use of case studies.

Course Materials: There are two textbooks for the course and a lab manual. The first book listed below (Foundations of Science) is an integrated science text that provides the scientific knowledge for the course. The second text (How to Think about Weird Things) provides an understanding of how to use both critical thinking and scientific reasoning to evaluate extraordinary/weird claims.

1) ***Foundations of Science - Custom*** (This is a custom edition of *Conceptual Integrated Science)*, by Hewitt, Lyons, Suchocki, and Yeh, 2012, Pearson/Addison-Wesley, San Francisco. ISBN 97812696855350

2) ***How to Think About Weird Things: Critical Thinking for a New Age*** – 7e, 2013, by Theodore Schick and Lewis Vaughn, McGraw-Hill. ISBN 9780078038365 (paperback).

3) **Lab manual:** ***Foundations of Science Lab Manual*** ISBN 9780738068237

Scantrons: You will need approximately 5 of the "long" Scantron test forms (the 100-question version; 50 on front and 50 on back [form #882-E]) and 10 of the "short" Scantron test forms (15 question "Quizzstrip"; form #815-E); you might also need a calculator for lab.

Supplementary Readings: If used, these will be distributed either in class or placed on BlackBoard.

Grading Criteria

Because the lecture and lab portions of the course are considered to be part of the *same* course, the final course grade is based on a combination of lecture tests, lecture coursework, *and* lab work. In other words, there is no separate lab grade. Specifically, the lecture tests constitute 48% of the grade, the lecture assignments constitute 24.6%, attendance constitutes 3%, and the lab assignments constitute 24.4%. Because of this, students must remain enrolled in both the lecture and lab for the entire semester; they cannot drop either the lecture or the lab and receive a grade for the course. The 4 in the 1436 designation for the course indicates that this is a 4-credit course that has a lab component.

Grading will be based on 3 lecture exams (including the final), eight (8) sets of reading questions, 3 group case study activities, 3 group homework assignments, individual and group lab quiz grades, peer evaluations by your fellow group members in both lecture and lab (see details below), a syllabus quiz, and attendance. You will also be given a **critical thinking assessment** at the ***beginning and end*** of the semester that serves as **extra credit**. This extra credit can be very important to your overall grade, so PLEASE do your best on both exams!

Please note that the number of assignments may be changed slightly (e.g., add or drop a homework assignment) if circumstances warrant such a change. If this happens, it will have a slight effect on the percentage points associated with each aspect of the course.

In an integrated course such as this, each topic serves as the foundation for subsequent material; consequently, **students should remember and understand all of the basic principles covered previously in the course** in order to apply them in the case studies and labs, and to do well on exams.

Tests: There are 3 major exams and each will consist of multiple-choice and matching-type questions, and will be worth 750 points. (Don't panic! There won't be 375 two-point questions – just a standard number of questions). Tests total 2250 points and constitute 48% of the total course grade.

Reading Quizzes: Each week, you will be assigned readings from the books listed above and, in some cases, from PowerPoint lectures that are posted on BlackBoard but which are not discussed in class. To ensure that students read these assignments, **a set of reading questions will normally be given every two weeks over the reading material**. These assignments will be ***completed outside of class*** **online, in BlackBoard.** You are asked to *use both your books and notes* to complete the assignments. Once available, you may re-take the reading quiz assignment as many times as you wish before the due date for the reading assignment. If you experience computer problems, please contact the online helpdesk (936-294-2780) before the assignment is due. The reading quizzes will be available for a week, or more, before they are due. **They can be retaken as many times as you want before the due date and it is the highest score that is accepted**. The quizzes are randomly created from a pool of questions. The pool typically consists of 60 to 90 questions. Because the computer randomly selects questions from the question pool when it generates a quiz, each version of the quiz will be different and may consist of some questions that are repeated, as well as new questions. The more times you take it, the more questions you will see before the test. We suggest you complete the reading quizzes early in case you have questions or computer problems. Because the reading quizzes are available for an extended period of time and can be re-taken before the due date, ***late reading quizzes will not be accepted***. Again, we do not recommend waiting to the last available day to complete the reading quizzes, as you may experience computer and/or technical issues. By attempting the quizzes earlier in the week, you will ensure you earn a higher grade and submit the assignment on time.

As regards the reading assignments, **I strongly recommend that you thoroughly read the material – don't just skim it**. **If you try to avoid actually reading the material and, instead, merely skim the chapter until you find something that 'looks right,' you will *not* learn the material. This technique really doesn't work because, as emphasized throughout the course, facts presented in isolation from one another don't make sense. You have to see the connections among the facts in order to make sense of them – and to remember them! This is why reading *all* of the material for comprehension does work!**

Pacing your work is the key to not being overwhelmed.

Once the quizzes have been submitted, the answers will be posted on BB. A screen will show you which questions you earned credit on and which you missed. In many cases, explanations are provided for the answers as well. Many students print off their completion reports for study guides. Please remember that this course is about ***understanding and reasoning – not memorization***. So, you should always look over the completion reports to ensure that you understand the concepts. **In other words, the quizzes and completion reports serve as a study guide for the readings.**

There are a total of **570** points possible for these quizzes, including 20 points for the **syllabus quiz**. Together, these are worth **12.2%** of the course grade.

Case Studies and Peer Evaluation

In this class, students will be divided into groups by the instructor. Each group will consist of about 5 students who will work together throughout the semester on both case studies and the three group homework assignments that will be completed outside of class. As you will see, **group scores are usually better than individual scores, and so this process normally *improves* an individual's grade**. In addition, ***group effort helps everyone learn the material better because everyone is involved in teaching one another***. So, individuals normally do better on tests as a result of this prior group preparation process – assuming they put in the effort. Group work in lecture constitutes 12.4% of the total course grade. Groups also will be formed in lab, and group work in lab constitutes 9.6% of the total course grade. **So**, **in total**, **group scores comprise 22% of one's grade in the course**.

Many students are initially uneasy about the idea of working in groups because it is often the case that, in previous classes, some members of their group did all or most of the work, while others did little or nothing – but everyone received an equivalent grade. This should **not be a problem** in this course because of the importance of group peer evaluation procedures to a student's grade. The procedures for performing peer evaluations are described below.

Peer Evaluation Process

If you are in a group consisting of 5 members (including yourself), you will be allotted 40 points to distribute among the members of your group following each group assignment. *You do not give points to yourself*. (If you are in a group of 6 members, you will be given 50 points, etc…) If you believe that everyone contributed equally to the group work, then you would pay/give everyone 10 on the assignment. If everyone in the group feels the same way, then everyone receives a total of 40 points from their peers, which results in an average score of 10 (40/4 = 10). Please note that 10 is the maximum number of points that may be awarded.

You must be fair in your assessments, but if someone in your group did not contribute adequately, then you should give them fewer points. **If they were not present or did not contribute to an assignment, they should receive no points.**

It is imperative that you assign these scores **PRIVATELY** (NOT in front of your team members) AND that you do this on the day the case study was conducted or the assignment turned in! **It is also critically important that you do not 'agree' to give each other good scores. This is guaranteed to undermine the integrity of the process and will inevitably result in bad feelings if someone in the group doesn't do his or her fair share of the work because he or she thinks they're going to get a good score no matter what they do.**

Also, in order to be fair and accurate, DO NOT wait until the midterm or the end of the semester to assign these participation scores (for reasons that will be apparent when we discuss the limits of peoples' memories); rather, **assign the scores immediately after the assignment is completed**.

At the end of the semester, your peer evaluation score is equal to the average of the amount of peer evaluation points you received from the members of your group - converted to a percent. Accordingly, an average of 10 points equals 100%; an average of 90 equals 90%, and so on. This score is then used to determine the number of *group* points that you will receive at the end of the semester. If you receive an average of 10, you will receive 100% of the points earned by your group on the group assignments. If you receive an average of 9.2, then you will receive 92% of the group points, and so on.

If you have an average of less than 7, you will not receive ANY of the group points.

Use the following additional criteria when assigning points:

1) Be fair! If a person made a genuine effort to contribute, then award 10. ***Do not give points to a student for an assignment if that student was absent*** *the day a group assignment was done in class. And, do not give any points on a group homework assignment if the person did not contribute.*

2) You cannot give anyone in your group more than 10 points. (This prevents people from giving their friends an unfairly large amount of points, which would necessarily hurt other members of the group because there would be less points to distribute to other group members).

3) **You do not have to distribute all of the points**. If someone does not contribute appropriately, then give him or her less than 10 points. And, as stated previously, if someone is absent in your group on the day of the assignment, then give him/her no points; i.e., a zero.

4) **As stated above, anyone receiving an average of less than 7.0 on his or her peer evaluation at the end of the semester will automatically lose his or her group-based points**. So, for example, if a student receives an average of less than 7.0 in lecture, the student will lose all of the group-based points earned by the group in lecture. This amounts to a maximum 580 points out of 4690 possible in the course and constitutes 12.4% of the total course grade; i.e., just over one letter grade. In the same way, if a student receives an average of less than 7.0 on his or her peer evaluation in lab, the student will lose all of the group-based points in lab, which is a

maximum of 450 points. This equals 9.6% of the total course grade. And, if a student received less than 7.0 in *both* lecture and lab, they would lose up to 22% of the total course points; i.e., more than 2 letter grades. The point is, "**Do your best to contribute to the group☺!**"

It is the last rule that normally ensures everyone will contribute to the group's efforts. Also, the fact that the score is an average prevents anyone who might be unfair in the awarding of points from single-handedly undermining the final grade of a group member. And, if one student gives a score that is much less than those of other students (which implies that it is unfair*), **I have the option of ignoring that score.*** In fact, I can override a low average score if there is evidence that the grade was unfairly assigned by the group. ***This serves as a safety net for each student***.

This type of peer-evaluation method has been used in many universities and works very well. Students like it because it encourages everyone to pull their own weight and contribute to the group.

Example: Imagine that a student named Linda received peer evaluation amounts in lecture of 8, 10, 9, 10, and 10, for a total of 47, which is an average of 9.4, or 94%. John received all 10s and so received all of the group points. Billy, who skipped class, didn't sit with his group, and contributed very little to the group, received scores of 2, 0, 3, 0, and 2 for a total of 7 points and an average of 1.4, or 14%. So, Linda received 94% of the group's overall grade for the semester. With an average of 14%, poor Billy lost 580 points, which means his overall course grade dropped by 1.2 letter grades. And, because his average was 71% before the deduction, Billy failed the course (71% - 12.2% = 58.8%). This is not the happy ending any of us wants to see!

How to Earn a Good Peer Evaluation Score

1) Sit with your group every day and learn everyone's names. Get to know them.

2) Come prepared to contribute to the case studies and quizzes by attending all classes (so you know what's going on), and reading the assigned material. In other words, make sure you can and do contribute constructively to the discussions.

3) Be positive and friendly and treat the other members of the group the way you want to be treated. In other words, be courteous and respectful of others' comments and ideas - even if you don't agree with them. Be willing to accept that your initial thoughts might be incorrect, but also don't be afraid to courteously express your views even if they are different from those of others in the group.

4) Contribute significantly to the group homework assignments. Do your part and do it on time – not at the last minute. * You should keep a copy of what you have written in case there is a dispute regarding your contribution. Remember, I can override the group's evaluation in the unlikely event that it was unfair. ***However, this normally requires that you be able to document what you contributed so that I can base my decision on evidence rather than hearsay***.

5) Come to any and all group meetings and, if you absolutely cannot be at a meeting because of work or other legitimate schedule conflicts, make sure you keep in touch with the group via e-mail, Facebook, or phone and let them know ***ahead of time*** that you can't come. Most people will understand if they know someone has legitimate reasons for not attending a meeting. But, you need to contribute ideas, written material, etc., even if you can't join the group in person.

An initial, trial peer evaluation will be done approximately half way through the semester. This evaluation will NOT count as part of the grade and will serve only to give each person feedback from the members of his or her group so that he or she can correct any problems that might exist.

Very important note: Although points are not given for completing peer evaluations, points will be deducted if the rules described above were not followed and/or if you do not submit a peer evaluation for your group members. Specifically, 40 points will be deducted for not submitting a peer evaluation when it is requested. So, please do the evaluation!

Homework Assignments

There will be **three *group*** homework assignments worth a total of 400 points (8.5% of course grade). These assignments entail analyses of actual arguments and claims. For example, the first assignment involves evaluating a series of arguments. The second assignment entails an analysis of a product that is available to "help maintain your health". The question your group will try to answer is, "Does it work?" "Is it based on science or pseudoscience?" Doing these assignments will help you evaluate the innumerable claims you will encounter in your life.

The third assignment is known as FiLCHeRS and is worth 220 points. This assignment involves the application of the FiLCHeRS rules (which are discussed in class) to an analysis of an extraordinary claim you will be assigned to evaluate. The assignment consists of both multiple choice and short answer questions and is a ***capstone*** assignment in that it entails using information learned *throughout* the course to evaluate the claim.

Attendance and Make-up Policies

This course abides by University Policy and Regulations concerning attendance (See the Undergraduate Catalog). Accordingly, "regular and punctual attendance" is expected of each student at Sam Houston State University:

In a course such as this, in which group effort is a significant part of the grade, students genuinely need to come to class so that they can contribute to their group's success. Those who are prepared and contribute positively will be highly valued by their group! This course also moves quickly and many ideas build on one another and are used throughout the course. So, if a student misses class, he or she will almost certainly be hurt academically. In short, attendance matters and *is required*.

Because attendance is so important, I give each student 150 points at the beginning of the semester. Although this is part of the total points possible for the course, it is non-academic (i.e., not dependent on tests and assignments) and so serves as a *grade cushion*. All you

have to do to keep these points is to come to class. How much easier can it get! However, because attendance *is* so important, ***students will lose 30 points for each unexcused absence after the first absence***. (In order for an absence to be *excused*, some form of documentation must be provided to show that it was legitimate; this can include a physician's note, a funeral announcement, legal notice, etc. The documentation must be provided within one week of returning to class.) Also, tardies can be counted as absences. So, if a student misses 6 times, is tardy 6 times, or has some combination thereof (e.g., three unexcused absences and three tardies), he or she will lose their 150 points, which equals 3.1% of his or her total grade.

If someone misses more than 6 times, that student automatically FAILS THE COURSE

So, please come to class!

Examples

0-1 absence/tardies – no point deduction
2 absences/tardies – 30 points
3 absences/tardies – 60 points
4 absences/tardies – 90 points
5 absences/tardies – 120 points
6 absences/tardies – 150 points (3.1%)
> 6 absences/tardies = F

Please understand that these policies are intended to prevent students from failing the class because of skipping so many classes that they can't learn the material. In effect, these attendance rules keep most students on track and reduces the number of students that might otherwise fail the course.

1. In addition to the required attendance/tardy policy, it is important that you stay for the entire class -- **please do not leave the class room early** unless you are sick or have cleared it with me before class begins**. Students can be counted absent if they leave the class early without permission.**

2. If you know you will miss a class (because of an excusable event, such as an "away" baseball game and you are a member of SHSU's baseball team), let me know ahead of time and we can make arrangements for a make-up exam.

   If, for whatever reason, you **miss an exam**, please contact me as soon as possible to determine if and when the exam may be made-up. Make-up exercises and exams are only allowed based on my approval, and only if you have contacted me within a reasonable amount of time (one day!) following the absence.

3. **Late Work Policy: The three group homework assignments are to be turned in at the beginning of class (on the day they are due). These assignments can be handed in a maximum of one class period after the due date; however, points will be deducted depending upon how late it is submitted. If, for example, the homework assignment is due on Tuesday at 9:30 AM, but is handed in on Tuesday at 1 PM, 5% will be deducted. If the paper is turned in on Wednesday, 10% of the value of the assignment will be subtracted. And if it is submitted at**

the beginning of the class on the Thursday immediately following the Tuesday due date/time, 20% will be deducted. It must be emphasized that, after that date, the assignment cannot be turned in and no grade will be received for the assignment.

*** This late policy does not apply to the reading quizzes. These cannot be completed after the due date and time.**

Please check BlackBoard as soon as the grades are posted. **Students have a maximum of two weeks to contest a grade**. For example, if the grade is incorrect, or if it was not posted, you need to notify me within two weeks of my posting of the grade. After two weeks, if no errors have been reported to me, the grade stands as is.

What happens if you miss a Case Study? If you miss a case study in lecture because of an excused absence, you can partially make it up by completing it on your own. This will entail writing an essay response to any questions that may have been asked in class regarding the case, as well as taking the quiz over the case study**. The maximum score that a student can achieve is the score earned on the assignment, OR the group's score – whichever is *lower*.** This policy ensures that your grade is tied to the group grade, but it also provides some grade 'cushion' for those that may be sick or unable to come to class on the day of the case study, while also discouraging students from simply skipping the day of a case study. ***Please remember that your group must (based on the rules for peer evaluations) give you a zero for group participation on the case study if you are absent***.

Lab Grades

The lab grade will consist of both individual scores and group-derived scores. Most of the labs will be based on case studies that will involve instructor-led discussions in which members of groups work together to develop responses, propose hypotheses and experimental designs, or offer explanations for what has been reported or observed. In short, labs involve a lot of discussion – both within each group and among groups. The lab instructor will facilitate these discussions. The discussions make the labs fun and interesting because they are not based simply on rote memorization and fill-in-the-blank activities; rather, they involve group discussion and exploration of topics.

At the beginning of the lab, each student will be given a short, Individual Lab Quiz (ILQ) over the information provided in the lab readings and relevant readings assigned in lecture. This is intended to ensure that everyone reads the ***lab exercise and textbook background readings*** (listed on the lecture syllabus) ***before coming to class so*** they will be prepared for the lab discussion. The quiz will include some vocabulary terms listed at the end of the lab exercise and related lecture notes and readings. Questions will be multiple-choice and/or short answer essay.

At the end of the lab, each group will be given a Group Lab Quiz (GLQ) regarding the information covered in lab. The group will work together as a team to complete it. Groups will be created by the lab instructor at the beginning of the year. The purpose for the group work is to enhance understanding of the material by having

group members help teach each other the material and reinforce the key concepts covered in the lab. The group scores obtained over the semester will be adjusted by the peer evaluation score the student receives from his/her peers using the procedures outlined on the peer evaluation form.

A total of 10 lab case studies will be completed and **students will be allowed to drop both their lowest individual and their lowest group lab grade.** Accordingly, the lab quizzes, both individual and group, total 1140 points. These points will account for approximately 24.4% of your overall course grade.

In summary, students can earn 690 *individual* points and 450 *group* points. **Please remember that, in this course, the lecture and lab grades *are combined* to determine your overall course grade.** Thus, there is a total of 1140 lab points possible in lab.

In total, the lab portion of the course grade constitutes 24.4% of your grade – which is almost identical to the amount that would be earned relative to a standard lecture + lab class. In other words, if you took a science class in which the lecture and lab were separate, and earned 4 hours of credit for this combination, the lab would constitute 1 of 4 total hours, or 25% of the grade component for the science class. **However, please remember that, in this course, the lecture and lab grades *are combined* to determine your overall course grade.**

Extra Credit

At both the beginning and end of the semester, you will be given the opportunity to earn extra credit worth up to 9% of the total course grade! That's 422 points! This opportunity to significantly improve your grade will be in the form of a critical thinking assessment – either the CAT assessment or the FSE assessment. This assessment, which will be given in lab, is required by the University's reaccreditation requirements. It is extremely important that you do your best on both exams because your scores reflect upon the university and indicates how well our students are doing relative to students at other universities in the United States. It's your chance to not only earn a lot of bonus points, but also to make SHSU look good! So, please do your best.

Each assessment is worth 120 points. The grading procedure for this assessment consists of simply *adding* the two scores together. However, if the sum of the two scores is above 144 points, a *multiplier* is used to further increase the number of points you can earn. (It's a bit like the multiplier used on some lotteries.) This means that the procedure for awarding bonus points is very generous.

For example, if you made a combined score of 110 points on the assessments, the 110 points will be added to your grade. **And, if your total on both assessments is greater than 144 points, you will receive even more extra credit points**! The amount you would receive for scoring above 144 points is equal to the number of points you earn above 144, *multiplied by 2* – **with a maximum of 190 extra points possible. (190 points is equal to 4% of the course grade.) So, if you received the maximum number points on these exams, you would receive a grand total of 430 bonus points (9% of the course**

grade), which is almost an entire letter grade! This is why it's important to do your best on both assessments.

For example, if you made a 70 the first time you took the assessment and a 95 the second time, you would have earned a total of 165 points. Because the combined score for the two assessments is 21 points more than 144 points, the multiplier is used and you would earn 42 *more* bonus points in addition to the 165 you'd already earned: 165 - 144 = 21; 21 x 2 = 42; **165 + 42 = 207 total bonus points**). *Because these are bonus points, they would NOT be adjusted by a peer score. They're all yours!

Because you are being asked to take this critical thinking assessment at the beginning of the semester (the pre-test) before you have been taught the course material, we do not want you to be discouraged if you do not do as well as you might have expected on the pre-test. That is why we give additional bonus points if you achieve a combined score above 144 – which is a mere 60% of the possible points on the assessments! Because the score on the second assessment (the post-test) **SHOULD improve if you learn from the course and you do your best on the assessment**, you can easily make a good overall score and earn a significant number of bonus points. ***You should know that a few students have actually earned the maximum number of bonus points possible!***

Please note that these assessments are the only possible sources of extra credit in the course. In other words, no individual extra credit is given and, with the exception of one individual and one group lab grade, no other grades are dropped.

Grade Determination

Your grade is based on the percentage of points earned relative to the maximum number possible for the course (4,690). The percentage of the total possible points determined by individual effort is 78% (3658 out of 4690 possible), and that determined by group effort is 22% (1143 out of 4690 possible). So, although group effort is fundamentally important to the design of the course and to the way in which labs and case studies are run, **your grade is determined *primarily* by your individual scores; i.e., by your individual effort**. In short, you are ultimately responsible for the majority of the grade points you earn in the course. **The group work should help you *do better* by helping you learn the material more thoroughly**.

Please note that The State of Texas REQUIRES that universities have students engage in group activities because it is crucial to their career preparation. This is an additional reason why group work is required and why you will evaluate one another's contributions to the group.

All of the tests and assignments for the course, including lab assignments, are listed in the **Grade Form on page 13**. To keep track of your grades, **you need to record each and every grade you receive on this form**. (***Please note that Black Board will not calculate your grade***; ***it's simply a place to store the grades for individual assignments***.)

Using the form below, you can *estimate* your grade at any point in the semester by comparing the total number of points you have earned to-date to the total number of points

possible at that point in the course. You can only estimate the grade because, prior to the end of the semester, your score on group work will not be adjusted based on your peer evaluations. ***However, you should have a very good sense of how you are doing based on the original, unadjusted group scores coupled with your awareness of your participation in the group.***

Abbreviations used in grade form

Lecture component	Lab Component
CS = Case Study	ILQ = Individual Lab Quiz
RQ = Reading Quiz	GLQ = Group Lab Quiz
SQ = Syllabus Quiz	
HW = Homework	
CT = Critical Thinking Test	

Grade Record Form

I. Lecture Grades (75.7% of total)

Individual grades

1. Test grades (48%)

Test 1 _____ (750)
Test 2 _____ (750)
Test 3 _____ (750)

A. Total test = _____

2. Reading Quizzes (12.2%)

SQ 1 _____ (20)
RQ 1 _____ (60)
RQ 2 _____ (40)
RQ 3 _____ (60)
RQ 4 _____ (60)
RQ 5 _____ (60)
RQ 6 _____ (40)
EnvHW____(50)
RQ 7 _____ (60)
RQ 8 _____ (60)
RQ 9 _____ (60)

B. Total Quiz = _____

3. Group Grades in Lecture (12.4%)

NASA CS ____ (60)
Xango CS ____ (60)
Argument HW____ (90)
Water HW ____ (90)
Vacc/Autism CS ____ (60)
FiLCHeRS HW ____ (220)

Total group lecture = _____

C. Total group x peer score = _____

II. Lab Scores (24.4% of total)

1. Individual Lab Scores (14.8%)

ILQ 1 ____ (74)
ILQ 2 ____ (77)
ILQ 3 ____ (77)
ILQ 4 ____ (77)
ILQ 5 ____ (77)
ILQ 6 ____ (77)
ILQ 7 ____ (77)
ILQ 8 ____ (77)
ILQ 9 ____ (77)
ILQ 10 ___ (77)

F. Total Individual ___ (Drop lowest ILQ)

2. Group lab Scores (9.6%)

GLQ 1 ____ (50)
GLQ 2 ____ (50)
GLQ 3 ____ (50)
GLQ 4 ____ (50)
GLQ 5 ____ (50)
GLQ 6 ____ (50)
GLQ 7 ____ (50)
GLQ 8 ____ (50)
GLQ 9 ____ (50)
GLQ 10 ___ (50)

Total group _____ (Drop lowest GLQ)

G. Total group x peer score ____

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4. Attendance (150 pts.) (3.1%)

-30 for each unexcused absence or tardy - after the first absence or tardy

D. Total Attendance ___ (150 max. if no absences)

5. **Extra Credit: Critical Thinking Assessment Scores (worth up to 9%)**

CT pre-test ____ (120 max)
CT post-test ____ (120 max)

E. Total CT points ____

To obtain your final grade (percent), add the totals labeled A, B, C, D, E, F and G, divide by 4690, and multiply by 100.

Point range for final course grade

A = 4221-4690	D = 2814-3282
B = 3752-4220	F = less than 2814
C = 3283-3751	

Academic Honesty: All students are expected to engage in all academic pursuits in a manner that is above reproach. Students are expected to maintain complete honesty and integrity in academic experiences both in and out of the classroom. Any student found guilty of dishonesty in any phase of academic work will be subject to disciplinary action that is consistent with university policies. Please read the following:

1) Students are encouraged to study in groups to prepare for tests. However, "group effort" is definitely not permitted when taking exams! This will result in an automatic zero on a test. Two such occurrences will result in an F in the course.

Proper Course Behavior: All of these rules are standard and are based on common courtesy, respect, and honesty – all of which are necessary to ensure a positive learning environment.

1) Students will refrain from behavior in the classroom that intentionally or unintentionally disrupts the learning process and, thus, impedes the mission of the university. Cellular telephones, pagers and ALL other electronic communication devices must be turned off before class begins.

   Students are prohibited from eating or drinking in class, using tobacco products, making offensive remarks, reading newspapers, sleeping, talking at inappropriate times, wearing inappropriate clothing, or engaging in any other form of distraction. Inappropriate behavior in the classroom will result in a directive to leave class. Students who are especially disruptive also may be reported to the Dean of Students for disciplinary action in accordance with university policy.

2) ***Please do not use cell phones or I-pods in class at any time, unless instructed to do so, because it distracts not only you, but the instructor and other students.*** If you use a laptop computer or I-Pad, please use it only to access the lectures.

   If you have an emergency-type situation that requires that you be in cell phone contact with someone (e.g., relative in hospital; spouse overseas in the military), then please tell me before class begins and put the phone in the vibrate mode.

3) **Please come to class on time**—there is no reason to be late to class on a frequent basis.

4) **Please remain in class until it is finished** because **leaving early disrupts the class and will count as an absence unless you have cleared it with me, or**

unless it is an emergency. If you have a job that overlaps with class time, then you need to drop the course or change your work schedule.

5) Please remove hats during exams.

6) **For obvious reasons, students CANNOT LEAVE THE ROOM DURNING AN EXAM and then return**. If this happens, the test will be taken up and your grade will be based on the portion of the test that you completed. **If you have a cold or allergy, please bring tissues to class so that you won't want to leave to get tissues during the test.**

Study Tips: Please read and follow these tips to enhance your grade in the course. I want you to do well!

1. **This course deals with arguments and evidence for or against certain claims. So, in order to study, you should imagine that you have been asked to write an essay in which you must present evidence and arguments to either support or refute a claim. This helps you learn and retain the material – and it makes the learning process more fun and interesting. This approach amounts to pretending that you are teaching the material to someone else.** You cannot simply memorize your notes and definitions and expect to do well on the tests. You must truly understand the material in order to obtain a good grade.

2. **Take notes.** Although significant amount of the information covered in class is presented in abbreviated form on the Power Point lectures, you will almost certainly need to write additional notes in order to recall, integrate, and understand the information. In addition, note taking requires active listening; i.e., a conscious attempt to determine what is important and to look for connections between ideas. Lectures aren't simply a bunch of facts and definitions thrown together. **In the class, the lectures are arguments either for or against certain claims and you'll need to understand the arguments**.

3. **Review your notes before the next class.** Constant reviewing will help you learn the material in smaller 'bites' of information – which makes it much easier to learn. Just as importantly, reviewing your notes before the next lecture will help you see how the previous material connects with the material to be covered in the upcoming class.

4. This course requires that students learn a significant amount of material on their own, independent from the lecture material. Furthermore, the reading quizzes are based on the reading material! **So, reading the textbooks and reader for this course really, truly is a necessity.** ***The ability to learn on your own is one of the most important skills you will learn in college, and it is one of the most important skills that employers look for in job candidates.***

5. When it comes time to **review for an exam**, first read the highlighted portions of the text, then concentrate on your notes. You might also want to follow the procedures below:

   a. As you review your notes, first concentrate on absorbing the key ideas and understanding the organization of the material - why certain ideas followed others in the class and how they are related.

b. Once this is done, begin to focus on the details - the "whys." As stated above, **tests in this course are absolutely not based on the mere memorization of definitions, or on the recognition of verbatim statements from lecture**; rather, the test questions assume you already know the definitions and that you understand the concepts discussed in lecture. **So, you will not be asked definitions; rather you will be asked to apply facts and principles, i.e., to think with the information you have learned**. Of course, you have to know the definitions to begin the process of answering questions; so, by all means, learn the definitions as the first step in learning the material☺

Visitors in the Classroom: Unannounced visitors to the classroom must present a current, official SHSU identification card to be permitted in the classroom. They must not present a disruption to the class by their attendance. If the visitor is not a registered student, it is at the instructor's discretion whether or not the visitor will be allowed to remain in the classroom. This policy is not intended to discourage occasional visiting of classes by responsible persons.

Americans with Disabilities Act: Any student seeking accommodations should go to the ***Counseling Center and Services for Students with Disabilities*** at the very beginning of the semester and complete a form that will grant permission to receive special accommodations. Please do not wait until test day to do this – **the request for accommodations must be done at the beginning of the semester and students that have permission to use the services at the Counseling Center must make appointments *several days ahead of scheduled tests*. Walk-ins aren't permitted**. Also, please be sure to send me an e-mail two days before an exam to remind me to take the test to the Counseling Center.

Religious Holy Days: If a student desires to be excused from class, assignment, or a test on a religious holy day, then the student must notify the instructor of each scheduled class that he/she will be absent for religious reasons. In such cases, the student will be required to take the test or submit the assignment early—unless there are good reasons for not being able to do so and the instructor has agreed to those reasons.

Special Circumstances: If unusual circumstances arise during the semester, such as a medical problem, death in the family, etc., which adversely affects your attendance **PLEASE discuss this with me <u>immediately</u> and provide documentation**. **Don't wait until the end of the semester to discuss the problem with me.** If you keep me informed, I will gladly do my best to accommodate your situation. However, please understand that, because of the nature of the course, there are limits as to how much can be excused and so, at some point, it may be necessary for you to drop the course. Also, if you wait until after-the-fact, at the end of the semester, to let me know that you were experiencing these adverse circumstances, there is nothing I can do about it at that time. I cannot retroactively make accommodations and I do not give extra credit assignments to make up for grade deficiencies.

SCHEDULE: **This schedule is subject to change at any time* based on class progress.
Major lecture topics are listed in bold-face, black font.

Reading assignments are in green font and include

all material covered since the preceding quiz
Case studies are in blue font.
Tests are in orange font.
Reading Quizzes are in red font.
Homework assignments are in purple font.

Please note that some of the readings include only sections of a chapter (indicated by the word "part"), whereas others include the entire chapter, indicated by the word "all". Please don't wait until the last minute to do the readings!

- FOS = Foundations of Science (custom edition of the *Conceptual Integrated Science* textbook by Hewitt et al.
- Schick = *How to Think about Weird Things* by Schick and Vaughn

		Lectures	Labs
1st	1/15	Introduction to course: **Weird Things People Believe** and "**Witch Trials of the Past and Present: Why Evidence and Reason Matter**" **Read FOS - Chapter 1 all: "About Science" pp. 1-14** **Read Schick – Chapter 1 all: "Close Encounters With the Strange" pp. 1-13**	No lab
		---	
2nd	1/20	Complete Witch Trials and begin **Nature of Science** **Read Schick Chapter 6: "Science and Its Pretenders" part 158-181 (nature of science & scientific reasoning)** **Read Schick – Chapter 3: "Arguments Good, Bad and Weird" parts 33-39 and 49-57.** (***Pay particular attention to pages 49-55 dealing with informal fallacies. You will reference these throughout the course***)	No lab
	1/22	Continue Nature of Science lecture ***Collect student information for creating groups*** **Syllabus Quiz due** **Reading Quiz 1 due**	

3rd	1/27	***NASA Activity*** **Read Schick Chapter 4:**	Labs Begin & Extra Credit -
	Pre		

"Knowledge, Belief and Evidence" parts 62-84 and
summary on page 90 (opinion vs. knowledge and expertise)
Argument Homework assigned: due 2/19

1/29 Nature of Science lecture
"**Why Things Aren't Always What They Seem to Be**"
Reading Quiz 2 due

4th 2/3 Begin lecture on the **Limits to Perception and Memory** Checks Lab
Read Schick Chapter 5: "Looking for Truth in
Personal Experience" part 96-143 (perception and memory problems)

2/5 Continue Limits to Perception and Memory
Reading Quiz 3 due

5th 2/10 ***Xango Case Study*** Salem Lab
Read FOS Chapter 2 all: "The Universe" pp. 15-34

2/12 Continue Limits to Perception and Memory
Read FOS Chapter 3: "The Atom"35-56
Read FOS Chapter 4 "Energy and Momentum" 57-76

6th 2/17 Begin Astronomy 1 Lecture:
Perception lab
"**What are those Lights in the Sky? Stars, Planets, Galaxies**" and
"**The Size of the Universe**"
Read Schick Chapter 7: "Case Studies in the
Extraordinary" part 234-248 (UFO abductions)

2/19 Continue Astronomy 1 lecture
Argument Homework due

7th **2/24 Test 1 (NOS & LPM)** Astrology Lab
Read Schick Chapter 4: "Knowledge, Belief and
Evidence" part 84-90 (astrology section)
Read FOS Chapter 5 "Heat" 77-98

2/26 Continue Astronomy 1 lecture
Reading Quiz 4 due
Read the *Laws and Relativity* lecture posted on BB.
This information is critical to doing the Star
Trek lab – especially the section on relativity.

8th 3/3 Begin Astronomy 2 Lecture: "**The Big Bang and** Star Trek Lab

the Nature of the Universe – or is it a Multiverse?"
Read FOS Chapter 6: "Describing Motion" 99-116
Read FOS Chapter 7: "Newton's Laws of Motion" 117-138

3/5 Complete Astronomy 2 lecture
"**Ghost Busting with Newton's Laws**"
Read Power Point lecture on Black Board titled "**The Paranormal – Part 1: History of Ghosts, Psychic Energy, Psychic Powers, Psychic Detectives, Psychic Healers and Mediums."**
******Mid-term peer evaluation due******

3/10 ***Spring Break***
3/12 ***Spring Break***

9th 3/17 Begin **Paranormal Phenomena** – Part 2 lecture Haunting Lab
AAW Water Homework assigned;
Part 1 (individual component) due 4/7
Part 2 (group component) due 4/14
Read Schick Chapter 2 all: "The Possibility of the Impossible" pp. 14-29 (the possibility of ESP and precognition)
Read Schick Chapter 6: "Science and Its Pretenders" part 197-213 (parapsychology)
Read Schick Chapter 7: "Case Studies in the Extraordinary" parts 220-227 and 248-276 (talking to the dead, near-death experiences, and ghosts)

3/19 Continue **Paranormal Phenomena** – Part 2 lecture
Reading Quiz 5 due

10th 3/24 Begin CAM 1 lecture on "**Complimentary, Alternative, and Quack Medicines and Diets: take two ginkgo tablets and some homeopathic elixir and you'll be fine!**" CAM Lab
Read Schick Chapter 7 (homeopathy) part 227-231
Read Schick Chapter 7 (climate change) part 283-288

10th **3/26** **Test 2 (Astronomy, Laws, and Paranormal)**
Read Schick Chapter 5 "Looking for Truth in Personal Experience" part 141-150 (anecdotal evidence, placebo effects and controlled studies)

11th 3/31 Continue CAM 1 lecture Geology lab
Read FOS Chapter 8: "Human Biology – Care and Maintenance" 139-160

		4/2	Begin CAM 2 lecture	
			Reading Quiz 6 due	
			Read FOS Chapter 9: "Rocks and Minerals parts 161-184	

	12th	4/7	Continue CAM 2 lecture	Natural Selection Lab
			Read FOS Chapter 10: "Plate Tectonics"	
			pp. 185-210	
			Read FOS Chapter 11 all: "The Solar System"	
			pp. 211-232	
			Water Homework part 1 due	
		4/9	***Vaccine-Autism Case Study***	
			Reading Quiz 7 due	

	13th	4/14	**Atlantis and Crystal Power; What Rocks**	Extra Credit - Post
			and Minerals Can and Can't Tell Us"	
			Begin lecture on The Origin of Planet Earth (Geology)	
			Water Homework part 2 due	
			FiLCHeRS assigned; due 4/30 (no late work accepted)	
		4/16	Finish Geology lecture and	
			begin **Cryptids** lecture – **"Legendary Creatures and a Discouraging Lack of Evidence: Nessie, Big Foot, and the Chupacabra!"**	
			Read FOS Chapter 12: "The Basic Unit of Life – the Cell" pp. 233-260	
			Read FOS Chapter 13 all: "Genetics" – pp. 261-286	
			Read Schick Chapter 8 all: "Relativism, Truth and Reality" -- pp. 295-315	

	14th	4/21	Finish Cryptid lecture and Begin lecture on genetics -"**Can Vulcans and Humans Make Babies? The Genetic Code of Life"**	***Whale Lab***
			Reading Quiz 8 due	
			Read FOS Chapter 14 all: "Evolution" -- pp. 287-316	
			Read Schick Chapter 6: "Science and Its Pretenders" part 181-197 (creationism)	
		4/23	**Finish Genetics and begin Evolution**	
	15th	4/28	Continue Evolution lecture	
			Reading Quiz 9 due	

4/30 "**There is Grandeur in this View: Evolutionary Theory as the Foundation of Biology: Scientific Synthesis and Consistency**"
Homework FiLCHeRS due
Peer evaluations due

Final – Covers material on Alternative Medicines and Diets, Geology, Cryptids and Principle of Ecology Power Point, Genetics, and Evolution and RQ 6 (dealing with Schick Chapter 5), RQ 7, and RQ 8, as well as the related lab material. It is *not* a comprehensive final exam, but you do need to know the logical fallacies and critical thinking tools used throughout the course.

Final Exam Time: Tuesday, May 5th from 8:00-10:00 AM

- **A summary list of all of the READING QUIZZES, their due dates, and the chapters they cover is provided on the next 2 pages.**

A summary list of the group homework assignments is provided on the last page of this document.

Reading Quizzes for Spring Semester 2015

**** All quizzes are due by 5:00pm on their respective dates below. If you experience computer or submission trouble, please contact the helpdesk (936-294-2780). Once the assignment has opened, you may take the quiz as many times as you wish, until the time it is due.***

- Schick = *How to Think about Weird Things* by Schick and Vaughn
- FOS = *Foundations of Science* text. * In addition to the new, custom *Foundations of Science* (FOS) page numbers, the earlier *Conceptual Integrated Science* (CIS) page numbers are also listed after the FOS page numbers in case you have the earlier edition. They are shown in green, italicized font.
- PowerPoint lectures on BB are in purple

Quiz 1: Thursday 1/22

1) Schick – Chapter 1 ***all***: "Close Encounters with the Strange" pp. 1-13
2) Read FOS - Chapter 1: "About Science" pp. 1-14
   (CIS – Chapter 1 ***all****: "About Science" pp. 1-12)*
3) Read Schick Chapter 6: "Science and Its Pretenders" ***part*** 158-181 (nature of science and scientific reasoning)
4) Read Schick – Chapter 3: "Arguments Good, Bad and Weird" ***parts*** 33-39 and 49-57. (Pay particular attention to pages 49-57 dealing with informal fallacies)

Quiz 2: Thursday 1/29

1) Read Schick Chapter 4: "Knowledge, Belief and Evidence" ***parts*** 62-84 and summary on 90 (opinion vs. knowledge and expertise)

Quiz 3: Thursday 2/5

1) Read Schick Chapter 5: "Looking for Truth in Personal Experience" ***part*** 96-143 (perception and memory problems)

Quiz 4: Thursday 2/26

1) Read FOS Chapter 2: "The Universe" pp. 15-34
   (CIS Chapter 28: all "The Universe" pp. 649-666)
3) Read FOS Chapter 3: "The Atom" pp. 35-56
   (CIS Chapter 9: "The Atom" ***part*** *167-179)*
4) Read FOS Chapter 4: "Energy and Momentum" pp. 57-76
   (CIS Chapter 4 on Energy ***part*** *63 -74)*
5) Read Schick Chapter 4 Knowledge, Belief and Evidence" ***part*** 84-90 (astrology section)
6) Read Schick Chapter 7: Case Studies in the Extraordinary" ***part*** 234-248 (UFO abductions)
7) Read FOS Chapter 5: "Heat" pp. 77-98
   (CIS Chapter 6 "Heat" ***part*** *98-104)*

Quiz 5: Thursday 3/19

~1) *Laws and Relativity* lecture posted on BB. This information is critical to the Star Trek lab

2) Read FOS Chapter 6 "Describing Motion" pp. 99-116
*(CIS Chapter 2 **all**: "Describing Motion" pp. 17-30)*

3) Read FOS Chapter 7: "Newton's Laws of Motion" pp. 117-138
*(CIS Chapter 3: "Newton's Laws of Motion" **part** 36-49)*

~4) *The Paranormal* lecture posted on BB– Part 1: History of Ghosts, Psychic Energy, Psychic Powers, Psychic Detectives, Psychic Healers and Mediums."

5) Read Schick Chapter 2 ***all***: "The Possibility of the Impossible" pp. 14-29 (the possibility of ESP and precognition)

6) Read Schick Chapter 6: "Science and Its Pretenders" ***part*** 197-213 (parapsychology)

7) Read Schick Chapter 7: "Case Studies in the Extraordinary" ***parts*** 220-227 and 248-276 (talking to the dead, near-death experiences, and ghosts)

Quiz 6: Thursday 4/2

1) Read Schick Chapter 7 (homeopathy) ***part*** 227-231

2) Read Schick Chapter 5 "Looking for Truth in Personal Experience" ***part*** 141-150 (anecdotal evidence, placebo effects and controlled studies)

3) Read FOS Chapter 8: Human Biology – Care and Maintenance" pp. 139-160
*(CIS Chapter 20: "Human Biology II – Care and Maintenance" **part** 461-463 and page 70 on the "Placebo Effect"*

ENV Homework: 4/2

1) Read Schick Chapter 7 (climate change) part 283-288

* This assignment includes an analysis of claims regarding global climate change. The information for this will be included as part of the assignment.

Quiz 7: Thursday 4/9

1) Read FOS Chapter 9: "Rocks and Minerals" pp. 161-184
*(CIS Chapter 23: "Rocks and Minerals" **parts** 531-537 and 541-552*

2) Read FOS Chapter 10: "Plate Tectonics" pp. 185-210
*(CIS Chapter 22 **all**: "Plate Tectonics" pp. 505-526*

3) Read FOS Chapter 11: "The Solar System" pp. 211-232
*(CIS Chapter 27 **all**: "The Solar System" pp. 320-338)*

Quiz 8: Tuesday 4/21

1) Read FOS Chapter 12: "The Basic Unit of Life – the Cell" – pp. 233-260
*(CIS Chapter 15: "The basic Unit of Life – the Cell" - **parts** 319-328 and 334-336 (cell reproduction)*

2) Read FOS Chapter 13 all: "Genetics" – pp. 261-286
*(CIS Chapter 16 **all**: "Genetics" – pp. 348-368)*

3) Read Schick Chapter 8 ***all***: "Relativism, Truth and Reality" pp. 295-315

Quiz 9: Tuesday 4/28

4) Read FOS Chapter 14 all: "Evolution" pp. 287-316
*(CIS Chapter 17 **all**: "Evolution" pp. 372-396)*

5) Read Schick Chapter 6: "Science and Its Pretenders" ***part*** 181-197 (creationism)

Group Homework Assignments

* These are group assignments and descriptions of them will be provided at the time they are assigned.

The argument assignment and the AAW Water Homework assignments require both individual and group effort. So, time must be allotted to coordinate work with the group members.

The FiLCHeRS homework assignment consists of both short answer and multiple choice questions. Some questions will require that you look up information on the Internet. For these questions, you will be asked to cite the web addresses of the sites you consulted to obtain the information.

1. Argument HW – assigned 1/27
- due 2/19

2. Water HW – assigned 3/17
- Part 1 due 4/7
- Part 2 due 4/14

4. FiLCHeRS HW– assigned 4/14
- due 4/30