

COGNITIVE DISSONANCE OF SCIENCE AND RELIGION IN  
PRE-SERVICE ELEMENTARY SCHOOL TEACHERS

by

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# **Chapter 1: Literature Review**

## **Introduction**

Science is not the only way of knowing and understanding. Science is a way of knowing that differs from other ways in its dependence on empirical evidence and testable explanations. The science teacher should present science in the science classroom in this manner. Since Galileo claimed that the Earth was not the center of the universe in early 1600, people have found conflict between science and religion. Often, these conflicts are resolved with time, such as the Catholic Church's acknowledgement of the theory of evolution. However, reconciling these conflicts requires each individual to reflect upon his or her own beliefs and come to a resolution. This is especially important for the science educator, who should present science without prejudice of personal feelings concerning religion.

## **Science and Religion**

A recent and significant item in the media concerning the conflict between science and religion has been the teaching of creationism alongside evolution. Although this feud between evolutionists (Charles Darwin, Thomas Huxley, Stephan Jay Gould and Richard Dawkins) and creationists (William Riley, William Bryan, Henry Morris and Michael Behe) may seem like a recent event of modern news articles and legal battles, it is not.

Perhaps the feud started with the trial of Galileo in 1633 (Linder, 2002). This infamous trial, although not dealing directly with evolution, certainly illustrates the concerns from both sides of the conflict between science and religion. In the trial, the

Catholic Church found Galileo guilty of supporting the false doctrine that the Earth revolved around the sun, the Copernican system. The sentence Galileo received was to remain under house arrest for the remainder of his life. The Copernican system since validated persists today as the correct understanding of Earth's solar system. A more recent example is the "Scopes Monkey Trial" of 1925 (Linder, 2008) in which John Scopes was placed on trial for illegally teaching evolution in a high school biology class. The court found Scopes guilty of violating Tennessee's Butler Act, which made it illegal to teach evolution and was fined \$100; the ruling was later overturned on a technicality. In 1968, the Supreme Court ruled it unconstitutional to ban the teaching of evolution (*Epperson v. Arkansas*, 1968). In 1981, Louisiana passed a law requiring public schools to teach evidence of 'creation science' alongside evolution; in 1987, the Supreme Court overturned this decision (*Edwards V. Aguillard*, 1987). These events mark changes of social, legal, and educational views of the conflict between science and religion. Yet, the conflict still exists and will continue, no doubt, in isolated cases for some time. For example, "REM lead singer Michael Stipe paused in the middle of a solo during a rock concert because he had Kansas on his mind. 'What's with Kansas and creationism?' he asked, looking puzzled" (Larson & Witham, 2010). Stipe was referring to the 1999 decision of the Kansas Board of Education to remove questions pertaining to evolution from the state standardized tests.

There is precedent for religious practitioners to be concerned with the teaching of evolution in public schools. According to Iqbal (2008), "Much has been said about Darwin's religious beliefs. What appears to be almost certain is that Darwin started out a believer and ended up an agnostic" (p. 11). Whether Darwin's research into evolution as an adult resulted in this profound effect, is of little concern;

the concern rests with the public's perception of the correlation. This perception fuels the question of whether or not it is morally responsible to ask a child of a Bible-based religion to learn evolution. As Lemke explains:

To adopt an evolutionist view of human origins is not, for a creationist, just a matter of changing your mind about facts, or about what constitutes an economical and rational explanation of the facts. It would mean changing a core element of your identity as a Bible-believing (fundamentalist) Christian. It would mean breaking an essential bond with your community (and with your god). It could lead to a social ostracism and the ruin of your business or job prospects. It could complicate your family life or your marriage chances. (Lemke, 2000, p. 301)

American schools first incorporated science into the curriculum in the middle of the eighteenth century. This introduction of science into public education met with resistance for several reasons. 1) Science did not support development of loyal and moral members of society. 2) Science sometimes threatened and/or undermined organized religious beliefs and authority (Kamens & Benavot, 1991). Brem, Ranney & Schindel (2003), acknowledged this conflict: "Evolutionary science has consequences for individuals and society, ranging from the way we interpret human behavior to our notions of spirituality and the purpose of our existence" (p. 181). 3) Many aspects of science, not unlike religion, are life-altering revelations. It may be in both cases the choice to experience these revelations is a choice of the individual, not a choice of public education.

While the trend has been for religions and society in general to accept that science does not pose a threat to religious beliefs, science has taken a non-

wavering stance against the incorporation of supernatural influence. This is because of the nature of science (NOS):

... that scientific knowledge is tentative (subject to change); empirically based (based on and/or derived from observations of the natural world); subjective (theory-laden); partly the product of human inference, imagination, and creativity (involves the invention of explanation); and socially and culturally embedded. (Abd-el-Khalick, Bell, & Lederman, 1998, p. 418)

Science is empirically based and derived from observations of the natural world, any knowledge that is derived in the absence of empirical evidence or any discoveries, which operate outside the laws of the natural world, fail to meet the criteria required to be classified as scientific.

Golshani (2005) addressed this aspect of division between science and religion in an eight-item questionnaire sent out to Christian and Muslim scholars.

1. What is your definition of science and of religion?
2. Do you see any conflict between your definitions of these two concepts?
3. Where do you think there may be a conflict between these two?
4. What has been the grounds for the development of conflict between these two?
5. What has been the role of religion in the development of science in the West?
6. Can we have a religious science?
7. Can science dispense with religion?



8. Can one separate the domains of activity of science and religion completely? (p. 1)

Golshani was astonished at the similarity of views of the 62 completed questionnaires. This begs the question of how a topic, which causes so little controversy among scholars of varying scientific disciplines, religions, and nationalities, can be so controversial within the current United States public education system.

Each of us personally has a balance between science and religion. The goal of education is to prepare our children to be productive members of society. This does not mean each child has to be a scientist. Yet, to function in society, each adult must have a working understanding of science. Robbins and Roy (2007) point out the difference between understanding science content (in this case evolution) and accepting it as truth.

We focused heavily on whether students changed beliefs; it is reasonable to ask whether persuasion is a reasonable educational goal. We categorically agree that no student should ever be graded on his or her beliefs--only on his or her understanding, and we feel that no teacher should adopt an evangelical strategy to "convert" students to "believe in" evolution. (p. 6)

In this context, the teacher is presenting (or allowing students to discover) the information and not asking that they agree or disagree. Robbins and Roy (2007) found many students incorporated the theory of evolution into their beliefs alongside those of their religion without conflict. At the turn of the Fifth century, St. Augustine struggled with these same conflicts within himself. Being a scholarly person, he

searched for his answers, which would resolve this conflict and came up with the following four points.

A. The doctrine of the unity of truth -- one and the same truth applies to both theology and natural or philosophical knowledge. Contradictions between the two must be resolved intellectually by the use of reason.

B. The doctrine of the two books -- the Book of Scripture (the Bible) and the Book of Nature (the created world). These are two complementary ways that God reveals himself to humans.

C. The doctrine of exegesis -- both books require careful interpretation. For example, biblical passages have layered meanings: a literal, an allegorical, an anagogical, and a moral meaning. Because biblical interpretation is very difficult, our explanations of some passages should be held only provisionally.

D. In terms of the pursuit of religion versus the pursuit of science or philosophy, religion has primacy, but scientific knowledge is an important handmaiden that assists true religion. (Levinson, 2006, p. 1)

Science and religion, of which both search for understanding and reason, are ongoing endeavors for humankind. They are difficult, provisional, and rewarding endeavors.

Within American schools, there are students from many different cultural backgrounds, religious beliefs, and customs. Different nations approach school science in different manners. Abd-el Khalick et al, (2004) points out how Taiwanese Science Curriculum differs from that found in the U.S. He states, "Taiwanese people prefer conforming to nature and searching for harmony between humans and nature, rather than taking control of nature. Thus, for the Taiwanese, philosophy of science

is Taoism and 'inquiry' refers to people's experiences with nature rather than their proactive exploration of nature" (p. 410). Many such differences from the American approach to science education exist in other countries. A common approach to the learning of science in America is using inquiry.

Inquiry is not a method used in all nations and has vastly different meanings among those that use it. Duschl (Abd-El-Khalick et al, 2004) points out the various phrases used by different countries to imply inquiry:

scientific processes; scientific method; experimental approach; problem solving; conceiving problems, formulating hypotheses, designing experiments, gathering and analyzing data, and drawing conclusions; deriving conceptual understandings; examining the limitations of scientific explanations; methodological strategies; knowledge as 'temporary truths;' practical work; finding and exploring questions; independent thinking; creative inventing abilities; and hands-on activities. (p. 411)

He also points out dichotomies extracted by means of descriptors and rhetoric from the six countries represented:

(a) learning science versus learning about science; (b) science as a search for truth versus science as a problem-solving activity; (c) raising and answering questions versus posing and revising explanations and/or models; (d) science as a cognitive activity versus science as a social activity; (e) demonstrating what we know (concepts) versus investigating how we know and why we believe it; (f) hypothetico-deductive science (causal experimental science) versus model-based science; and (g) science as a process of justifying and testing knowledge claims versus science as a process of

discovering and generating knowledge claims. (Abd-el-Khalick, et al., 2004, p. 412)

These summaries emphasize the different attitudes toward science among different countries. Some of these variations are the result of cultural differences, not the least of which is religion. These are indicative of the differences in attitude toward science that are present in any science classroom in America. These different attitudes towards science could greatly influence how students accommodate science in relation to their religious beliefs.

### **Nature of Science**

NOS is a complex, ever changing concept open to interpretation. Abd-el-Khalick, Bell, & Lederman (1998) explain, "Typically, the NOS has been used to refer to the epistemology of science, science as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge" (p. 418). Although NOS has some tenets, which are subject to controversy, there are basic tenets of NOS, which are general in nature and all encompassing about which there is little or no contention between different philosophies of science. These are:

That scientific knowledge is tentative (subject to change); empirically based (based on and/or derived from observations of the natural world); subjective (theory-laden); partly the product of human inference, imagination, and creativity (involves the invention of explanation); and socially and culturally embedded. Two additional important aspects are the distinction between observations and

inferences, and the functions of, and relationships between scientific theories and laws. (Abd-el-Khalick, Bell, & Lederman, 1998, p. 418)

## **Nature of Science and the Learning of Science**

Much as education is the passing down of rules on 'how to successfully participate in a society', teaching nature of science prepares students to successfully understand the workings of science. As education contributes to success in life, understanding the nature of science contributes to the understanding of science.

Effective science teaching will make apparent the scientific community's fundamental assumptions underlying scientific knowledge and, most important, their utility so that students can cross into the science culture (at least for the purposes of engaging in science instruction) and understand, as opposed to memorize, scientific explanations of natural phenomena. (Clough, 2000, p. 16)

## **Nature of Science (NOS) and Religion**

On an individual basis, NOS is the lens through which a person views science. Lederman (1992) explains, "For example, an individual's beliefs concerning whether or not scientific knowledge is amoral, tentative, empirically based, a product of human creativity, or parsimonious reflect that individual's conception of the nature of science" (p. 331). Just as science and religion have a history of conflict; it is not hard to conceive that individuals' religious beliefs would affect their perceptions of the NOS. Just as the subject of disagreement between religion and science, the degree of that disagreement and the length of the disagreement have varied throughout history, so has the definition of NOS.

Concomitantly, conceptualizations of NOS have changed with developments in history, philosophy, and sociology of science: disciplines that systematically investigate the scientific endeavour [*sic*]. These developments have, in turn, resulted in changing the ways in which science educators and science education organizations have defined the phrase 'NOS' since the turn of the century. (Abd-El-Khalick, 2000, p. 666)

Not unlike how NOS has adapted to changing culture, religions have adapted to the discoveries of science, including discoveries such as the Earth revolving around the sun and evolution by natural selection. However, how one understands NOS can greatly influence the way in which one can adapt his religion to these discoveries.

### **The Problem with Misconceptions**

Although there are fundamentals of NOS that most scholars and scientists would agree upon, NOS is a belief about science as seen through individual lenses. This belief must be incorporated and exist alongside each individual's existing beliefs.

The findings confirm that learning and understanding concepts are functions of how the new knowledge fits in with preexisting attitudes and articulated beliefs. Our study demonstrates that combined beliefs about religion (among other things) and about science strongly influence how students evaluate evidence for evolutionary theory by delimiting what counts as evidence and eventually interfering with understanding the theory. (Dagher & BouJaoude, 1997, p. 440)

As evidenced by the historic hesitation to accept that Earth was not the center of the universe, this phenomenon is not limited to the theory of evolution.

As documented in the Harvard University documentary video *A Private Universe* (Schneps, 1989), underlying misconceptions are difficult to restructure. Simply pointing out the fallacy of the students' conception and giving them a replacement does little to change their preconception. The "conceptual change model" (Stepans, 1996) outlines six stages that help to change the students' preconceptions and emphasizes the difficulty of replacing the existing misconceptions. The problem with religious beliefs is they are not misconceptions. This poses the problem of the students accommodating new information which seems to conflict with existing information. Dagher & Boujaoude (2005) give the example:

"... students used the view that scientific knowledge changes to reject scientific theories especially if they clash with their religious understandings. In light of their acceptance of religious knowledge as immutable, and their recognition that scientific knowledge is evolving, they find it perfectly logical to favor the former over the latter." (p. 388)

Clough (1997) addresses a method to challenge these misconceptions: "The key is to maintain disequilibrating experiences throughout the course. By maintaining a sense of dissatisfaction with previously held ideas, most students will begin looking for alternative ideas" (p. 192). If the maintaining of disequilibrium and a sense of dissatisfaction with previously held ideas is a successful intervention, it would seem this same approach would work for accepting science as science and religion as religion.

## **Attempts to Infuse Science with Intelligent Design**

The latest attempt at infusing science with the supernatural is Intelligent Design. Unlike creationism, Intelligent Design has the support of some scientists and is not religious in origin. In "Science and Religion Twenty Years After *McLean v. Arkansas: Evolution, Public Education, and the Challenge of Intelligent Design*;" Beckwith (2003) describes McLean's suit against Arkansas. He argues that "the reasoning on which McLean is grounded, reasoning that may have been applicable in 1982, to the question of the permissibility of teaching creationism, is not applicable today to the question of whether a public school runs afoul of the Establishment Clause if it permits or requires the teaching of Intelligent Design" (p. 1). He uses the basis for the ruling handed down in *McLean v. Arkansas* to point out item for item how that which applied to Creationism does not apply to Intelligent Design.

Johnson (2006) does not agree and predicts that the Intelligent Design movement will fail in the high court: "This issue eventually will reach the U.S. Supreme Court, and that court will find, as it did in *Edwards v. Aguillard*, that intelligent Design constitutes a religious belief and does not warrant equal time in the science classroom" (p. 8). Yet, even a decision handed down by the Supreme Court, is not an adjustment to public sentiment. Brandt-Rauf (2006) states: "As a scientist, it seems to me scientifically sound to concede that science may be a path to the truth but not necessarily the only path to the truth" (p. 1). His position is for the inclusion of Intelligent Design as a part of science, yet truth may still be sought and separated by the truth of how (the science aspect) and the truth of why (the religious or Intelligent Design Aspect).



## **Purpose and Significance**

The purpose of this study is three fold:

- a) To determine if cognitive dissonance between science and religion exists in pre-service elementary school teachers.
- b) To determine when such cognitive dissonance exists, do these pre-service elementary school teachers understand why it exists?
- c) To understand if and how these teachers deal with this cognitive dissonance should it exist.

This area of research is important because of the:

- a) continued concern with separation of church and state within public classrooms.
- b) influence that teachers have on students.
- c) nature of science and its importance to the understanding of science.

## CHAPTER 2: METHOD

This study took place at a small, private university in north central Texas. The participants were 10 students enrolled in a science content course for pre-service teachers that was highly infused with nature of science (NOS). Nine of the 10 participants were female, one male. Students' ages ranged from 18 to 26. The course was offered during the May term and met each weekday from 9:00-12:00.

Throughout the course, various sources of data were collected (both for research purposes and for students to earn their grade in the course). Some of the deliverables were graded on an individual basis and were turned in with the students' names on them. These included film-analysis worksheets, which the students used to record where they observed nature of science aspects and science content portrayed in a selection of mainstream films, content investigation reports (based on each film watched), animal observation assignments (completed at the zoo), and a final paper (which described the portrayal of science across films and articulated the students' perceptions of NOS).

To encourage students to share their personal beliefs and opinions (without fear of ridicule), other assignments were turned in using code numbers anonymously given to the students. These anonymous deliverables included pre- and post-surveys of students' perceptions of science and religion and their attitudes towards science as well as journaling assignments given throughout the term.

The pre- and post- surveys were conducted on the first two days and the last day of the semester. The journaling assignments were given after class ended as homework assignments. The journal prompts (or questions to be answered) were e-

mailed to the class. Based upon the events of the day, these specifically addressed any issues that arose during class discussions that explored NOS aspects. Students would type their journal entries and identify the entry only with their code number before turning them in at the beginning of the following class session. Because code numbers were used, these items could not be graded individually as a part of the students' course average. Instead, the items were assigned grades based on the number of completed assignments turned in. For example, if all students turned in a journal assignment, all students earned a 100% on that item. Students responded favorably to this system as indicated in their journal entries. One remarked, "I think journaling (esp. anonymous) is a great way to see where everyone stands without making anyone feel uncomfortable" (202, 2010).

**Day One:** Much of the first day was devoted to introducing the students to the goals of the course, establishing a safe learning environment and collecting baseline data on students' perceptions of science and religion. The Views of Nature of Science Questionnaire Version D+ (VNOS D+) (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002) (Appendix A) was administered during class. This instrument consists of 10 open-ended questions that are designed to elicit students' conceptions of NOS. Because the instrument requires much writing, the students were given a digital version that they completed using a computer in hopes that the greater ease in typing over handwriting would facilitate more in-depth answers. The Religious Questionnaire, a modified version of the one used by McClelland (1951), (Appendix B) was assigned as part of the homework journaling assignment. The purpose of this questionnaire was to give insight into each student's religious outlook.

**Day Two:** Students completed a modified Attitudes Toward Science Inventory (mATSI) (Weinburgh & Steele, 2000) (Appendix C). The students were guided through a class activity based upon the 'Ordeal by Check' (Crue, 1932) (Appendix D). This activity consists of approximately 45 checks, which are intended to give clues to a story, the details of which are never confirmed. The students worked in three groups, each group receiving approximately ten checks. The students were tasked to develop an explanation (story) based on the information contained on the checks in their possession. Students then shared their story with the class. The stories (and evidence) from each group were then used, allowing the class to develop a new (more complete) story based on all available evidence. The students realized the story changed with each new set of evidence that after all the evidence was used; they still did not have a complete story. They were frustrated that no solution (final story) was provided. After completing the 'Ordeal by Check' activity, the students were introduced to seven major tenets of NOS through a PowerPoint lecture given by the instructor. The tenets addressed were:

- Tentative
- Empirical
- Subjective
- Creative
- Socially & Culturally
- Observations & Inferences
- Theories & Laws

After class, students received the following prompts for their nightly journal entries:

***I hope you will take the journaling assignments seriously and***

***really give yourself at least 1/2 hour to think about and respond to the prompts.***

*During today's activity, I spoke about the tentative nature of science. I told you that some folks find this a bit unsettling as they consider what is in science textbooks to be "gospel". Considering that the survey from yesterday was about religion, and my serendipitous use of a religious reference in context of science, I thought I would give you the following prompts.*

- 1) What level of "Truth" does one find using the methods of science? In other words, how confident can one be with the claims of scientists?*
- 2) How does the "Truthfulness" of scientific claims compare to religious claims?*
- 3) Anything else you want to comment on about today's class session?*

**Day Three:** Students watched the film *Twister* (Bryce & De Bont, 1996) to identify NOS and Science content. Students were given NOS/Science Content worksheet (Appendix E) to use as they watched the film. They were instructed to record the circumstances in the film where they observed the seven aspects of NOS exemplified. Students annotated their entries on the worksheet with the runtime of the film to allow for reference, review, and discussion. The students also documented instances in the film where they saw scientific content portrayed accurately, inaccurately, and questionably. Students were told that their notes would be used to discuss NOS and science content of the film during a later discussion.

Students were asked to reply to the following prompts for their nightly journaling assignment.

***I hope you will take the journaling assignments seriously and really give yourself at least ½ hour to think about and respond to the prompts.***

**Part 1:**

*In Twister, the storm chasers are trying to get “Dorothy” inside a tornado so they can collect empirical data about the inner structure of tornados. They hope to use this data to help them develop advanced warning systems. In other words, once they develop sufficient technology to make the needed observations, the natural phenomenon can be understood.*

*If sufficient technology was developed so that scientists could make ALL OBSERVATIONS about the natural world, do you think they would be able to explain ALL THE NATURAL WORLD?*

*Or...*

*Do you think that some aspects of the natural world will ALWAYS BE A MYSTERY... regardless of how many observations we are able to make?*

**EXPLAIN YOUR ANSWER AND GIVE EXAMPLES!**

**Part 2:**

*Now that we have begun to further explore the Nature of Science, I want you to tell me how much conflict you feel between science and*

religion. Circle the number below (on a 0-10 scale) the level of conflict you feel exists.

No conflict between them ←-----→ Much conflict between them  
0 1 2 3 4 5 6 7 8 9 10

**Explain your answer and give examples**

**Part 3:**

*Anything else you would like to tell me about the class at this point?*

**Day Four:** Discussion of the NOS found in the movie *Twister* (Bryce & De Bont, 1996). The students' journaling assignment was the following:

***We have discussed Nature of Science quite a bit already and have explored how scientists can use empirical evidence to make predictions about the natural world. We have discussed tornados, volcanoes, hurricanes, etc. already in class and over the weekend, you will be exploring the cause of tornados.***

***Consider for a moment, another disastrous event that can occur; earthquakes. Scientists might explain the recent earthquake in Haiti by describing tectonic plates moving in alternative directions, building up force, and then releasing force which caused the disastrous event. There is, however, another explanation of this phenomenon that has been discussed. Pat Robertson, a widely known religious leader, has stated that Haiti suffered the earthquake it did because the Haitian people were***

***involved in a pact with the devil. Here is a link to a video of his explanation;***

<http://www.youtube.com/watch?v=f5TE99sAbwM&feature=related>

*After watching Twister, I realized that Jo explained tornados in a similar way (at one point in the film) when she said that she had seen a tornado skip over other houses and come after her. She implied that somehow, the tornados were out to get her family or her father, or herself. At another point in the film they describe an F5 tornado as “the finger of God.”*

*My questions, then, are...*

- 1) ***Could*** Pat Robertson’s explanation of the events in Haiti and/or Jo’s thoughts about tornados “coming after” her be true? Explain your answer.
- 2) ***Could*** either of these ideas about earthquakes or tornados be considered scientific? Explain your answer.
- 3) *Anything else you want to share with me?*

**Day Five:** Students watched the film *Jurassic Park* (Kennedy & Spielberg, 1993) and used the NOS/Content worksheet to identify NOS and science content portrayal as they did with the previous film.

**Day Six:** Students' engaged in a class discussion about the science of *Twister* (Bryce & De Bont, 1996) based on student weekend research on tornadoes. These content discussions were to explore the science concepts that were portrayed



in the film. Students brainstormed what science should be investigated from the movie *Jurassic Park* (Kennedy & Spielberg, 1993).

**Day Seven:** Students watched *Gorillas in the Mist* (Guber & Apted, 1988) and used the NOS/Content worksheet to identify NOS and science content portrayal as they did with previous films. The students were given the following journal prompts concerning the film.

*At the end of Dr. Leakey's lecture (at the beginning of the film), he describes his driving motivation as:*

***"I want to know who I am and what has made me this way."***

- 1) *Try to "get inside" Dr. Leakey's brain for a minute. Why do you think he believes understanding gorillas will help humans understand "who we are" and "what has made us this way"?*
- 2) *Do you agree with him or disagree?*
- 3) *How does the science in *Gorillas in the Mist* differ from the science in *Twister* and *Jurassic Park*? How are they similar?*
- 4) *Did today's film "trigger" any other thoughts that you would like to share? Did you like it? Dislike it? Did it cause any emotions to stir in you?*

**Day Eight:** Class discussion of *Gorillas in the Mist* (Guber & Apted, 1988). The geological time line was presented depicting events such as formation of Earth, life's first existence on Earth, dinosaurs' existence, and humans' existence. This time line also was presented in a condensed format referenced to a year. Students were given the following assignment.

*Part 1:*

*We are working towards learning about WHO the apes are and where/how they live.*

*Your task is to do the following for a) Gorillas, b) Chimpanzees, and c) Orangutans.*

- 1) Describe each group of ape (identifying any subgroups) and tell where they are found in the wild.*
- 2) Identify their taxonomy and describe how they differ from other apes **and** other primates.*
- 3) Describe their current status (number of individuals still living, amount of habitat remaining, any breeding programs, etc.). If they are endangered please describe how that came to be.*
- 4) Describe their intelligence – comparing them, specifically, to humans.*
- 5) Describe how scientists claim these great apes are related to humans by providing a diagram demonstrating their relatedness (the family tree of the apes).*
- 6) WILDCARD – tell me anything else you have learned that you think is worth sharing with the class.*

*Part 2:*

*Will be sent later for you to do at the zoo.*

*I will also send details about tomorrow so you will know where to go and what to do in the morning.*

**Day Nine:** Students went on a field trip to the zoo. While at the zoo, students were tasked with making detailed observations of prescribed (different for each student) animals and submitting a written report of these observations.

**Day Ten:** Students were given the following journal prompts.

***This journaling assignment will take a bit more time than previous assignments. I want you to spend some time developing your answers and giving examples when needed.***

*During today's discussion, we talked about scientific understanding about when dinosaurs existed in relation to when humans existed.*

- *According to scientists, our genus "Homo" did not appear on Earth until approximately 2.5 million years ago and modern humans did not appear until approximately 200,000 years ago.*
- *Furthermore, scientists assert that dinosaurs had gone extinct approximately 65 million years before the first human ever existed.*

*This causes me to ask the following three questions:*

- 1) *Do you accept the claims (listed above) as correct and factual information? In other words, do you believe those claims are true? **Explain your answer.***
- 2) *Do you believe that the claims (listed above) are the best scientific explanations of observed phenomena? **Explain your answer.***
- 3) *If dinosaurs were the topic of science lessons in a classroom, should the claims (listed above) be taught? Should any contradictory claims (to those listed above) be offered as explanation? **Explain your answer.***

**Day Eleven:** Class discussion on the similarity between humans and the four groups of great apes: gorillas, chimpanzees, bonobos, and orangutans. Students were given the following prompt for their journals.

***I hope you will take the journaling assignments seriously and really give yourself at least 1/2 hour to think about and respond to the prompts.***

*Part 1:*

*Today in class, we discussed the similarity between humans and the four groups of great apes: gorillas, chimpanzees, bonobos, and orangutans. We pointed out how these great apes experience (at least we believe they do) emotions similar to humans, possess intellect as high as many of our own species, and have genetic identity reaching as high as 99.4%!!!*

*With that being said, how does this make you feel? I DON'T WANT A SHORT-AND-TO-THE POINT ANSWER ON THIS ONE. I really want to know if this causes you any concern. Does it make you feel differently about these species than you would to other organisms less similar to humans? Do these species deserve more than other species?*

*Does their similarity to humans in any way decrease the importance of humans? Does it, in any way, elevate the importance of other species (either apes or all species)?*

*Come on and dig in and really tell me what you think!!!*

**EXPLAIN YOUR ANSWER AND GIVE EXAMPLES!**

**Part 2:**

*In light of part one, I want you to tell me how much conflict you feel between science and religion. Circle the number below (on a 0-10 scale) the level of conflict you feel exists.*

No conflict between them ←-----→ Much conflict between them  
0    1    2    3    4    5    6    7    8    9    10

**Explain your answer and give examples**

**Part 3:**

*Anything else you would like to tell me about the class at this point?*

**Day Twelve:** Students watched *Contact* (Zemeckis & Zemeckis, 1997) and used the NOS/Content worksheet to identify NOS and science content portrayal as they did with previous films.

**Day Thirteen:** Class discussion on the film *Contact* (Zemeckis & Zemeckis, 1997). Students began to work on their final paper depicting 'tentative nature of science', 'empirical nature of science', 'creative nature of science', 'observations and inferences', 'subjective nature of science', 'social and cultural nature of science', and 'theories and laws' as seen in each of the four movies viewed.

**Day Fourteen:** Students worked on final paper

**Day Fifteen:** Students finished final paper, took post test mANSI, VNOS and conflict between science and religion surveys.

## Chapter 3: RESULTS: Case Studies

### Student 448: Jill

Jill enjoyed filling out the VNOS survey. She stated:

I liked the survey because it really got me thinking about what I know about science and how I think about science. I liked how each question was on somewhat of a different topic and took me back to when I learned about each of the topics.

With the highest pre-mATSI score, 45, Jill seemed engaged in the science aspect of the course from the very beginning.

In response to the prompt: "If the text said, 'There was a great flood that covered the Earth,' you would interpret that as ..." Jill selected the response, "There was a flood that covered all land on Earth." Because this was set within the context of, "If the scriptures of your religion contained the following phrases, indicate how you would interpret the phrases," this would imply Jill believes it possible that at one time during humankind's existence on Earth there was a flood that covered all land on Earth.

As her response to the prompt of, "If the text said, '... and the Earth stood still', you would interpret that as ..." Jill selected the response, 'The Earth stopped revolving on its axis and rotating around the sun.' This implies Jill believes it is possible that at one point the Earth stopped revolving on its axis and rotating around the sun.

In response to the prompt concerning Biblical text, "If the text said, 'The world was created in 6 days', you would interpret that as ...," Jill selected the response,

"The world was created in 6 24hr days." This implies that she believes the world was created in six 24hr periods.

Jill thought, "It was a curious way to start off the class, with a discussion about religion vs. science. It made me think about where my religious beliefs started and how I learned about science." This again fits with the purpose of presenting the material in this manner, allowing students to be cognizant of both their feelings toward science and religion.

After the day of NOS discussion, then a day of watching the movie *Twister* (Bryce & De Bont, 1996) and analyzing it for NOS content, Jill rated feelings of conflict between science and religion at a six on a scale from zero to ten with zero being no conflict and ten being much conflict. After watching *Jurassic Park* (Kennedy & Spielberg, 1993) and *Gorillas in the Mist* (Guber & Apted, 1988), Jill's rating concerning conflict between science and religion remained a six. In the post science/religion conflict survey, there was no change from agreeing with 'There is a conflict between science and religion,' agreeing that 'Science and religion are two completely separate things,' changed to neutral. Jill explains:

I still look to religion to understand my views and understanding of the world but science can help make sense of unknown things by providing facts and evidence. Even though my views didn't change, I am more interested in the subject because I have a better understanding of its inner workings. This class really helped me to get a firm grasp on what science is and what it does in the world.

It was satisfying to know that Jill walked away from this class with more interest in science. Yet, what will Jill's science classroom look like? She was asked to respond to the following question. Should it be taught that modern man did not

appear until approximately 200,000 years ago and that dinosaurs went extinct 65 million years before humans existed exclusively, or should other contradictory claims be also offered as explanation? Jill's response was, "I believe that these claims should both be taught and the contradictory claims should be offered as long as it is explained to the students that there is not a right or wrong answer as far as what they believe in." What will Jill's students learn about the world they live in? (She commented, "Allow students to see the world as they want because that is the beauty of learning.") Jill is confident in her understanding of science. "This class really helped me to get a firm grasp on what science is and what it does in the world."

#### **Student 450: Jan**

Jan did not like filling out the pre-VNOS questionnaire. "I didn't enjoy the survey that we did this morning because I feel like I didn't know very many of the answers." Her pre-test mATSI score of -15 (average for class was 24.4) is well in line with the student's statement. Two question responses on the pre-mATSI would seem to be of concern for a perspective teacher: the first weakly agreeing with, 'When I hear the word "science", I have a feeling of dislike.' and the second, weakly agreeing with, 'I would like a job that does not use any science.'

In response to the prompt: "If the text said, 'There was a great flood that covered the Earth,' you would interpret that as ...," Jan selected the response, "There was a flood that covered all land on Earth." Because this was set within the context of, "If the scriptures of your religion contained the following phrases, indicate how you would interpret the phrases," this would imply Jan believes it possible that



at one time during humankind's existence on Earth there was a flood that covered all land on Earth.

In response to the prompt concerning Biblical text, "If the text said, 'The world was created in 6 days', you would interpret that as ..." Jan selected the response, "The world was created in 6 24hr days." This implies that she believes the world was created in six 24hr periods.

Her response to the prompt of, "If the text said, ' ... and the Earth stood still', you would interpret that as ..." Jan selected the response 'Not sure what happen but the Earth did not literally stand still.' This implies Jan would not interpret scripture stating, "the Earth stood still" to mean that the Earth literally stopped rotating and revolving around the sun. "I am not the most religious person you will ever meet." Yet, unlike the VNOS questionnaire, Jan stated, "I enjoyed the religion/science survey that we had to fill out." Part of the intention of presenting the NOS material in this course alongside the subject of religion was to make the students aware of any conflicts they may have between the two. Jan acknowledges that from the beginning this conflict interaction was enjoyable, interesting, and prevalent:

The survey [religious/conflict between science and religion] made me really think about how I feel about certain things and I enjoyed it. I think it's going to be interesting discussing the issue of science and religion in class because that is such a major thing going on and it will be prevalent in our classrooms.

In the religious survey, Jan indicated strongly agreeing with, 'There is a conflict between science and religion.'

After the day of NOS discussion, then a day of watching the movie *Twister* (Bryce & De Bont, 1996) and analyzing it for NOS content, Jan produced feelings of conflict between science and religion at a seven on a scale from zero to ten with zero being no conflict and ten being much conflict. After watching *Jurassic Park* (Kennedy & Spielberg, 1993) and *Gorillas in the Mist* (Guber & Apted, 1988), Jan's rating concerning conflict between science and religion increased to a nine. In the post science/religion conflict survey, there was no change from strongly agreeing with 'There is a conflict between science and religion,' while agreeing that 'Science and religion are two completely separate things,' changed to strongly disagreeing. Although these seem like conflicting opinions within themselves, the student's statement concerning scientists claims 'of when dinosaurs existed on Earth and when man existed on Earth,' may alarmingly explain holding both these opinions.

Yes, I do think that these claims should be taught in the classroom. I also believe that children need to be taught contradictory claims and let them decide for themselves. The teacher shouldn't influence the children at all; they should let the children think about it for themselves. I think the children should be taught these claims because they are going to have questions about why they dinosaurs are gone and if humans ever interacted with dinosaurs. We as teachers, need to give them the answers that they want and need to grow and learn.

### **Student 995: Joan**

Joan thought the VNOS was interesting because she had never thought about those kinds of questions. In response to the prompt: "If the text said, 'There was a great flood that covered the Earth.' you would interpret that as ...," Joan

selected the response, "There was a flood that covered all land on Earth." Because this was set within the context of, "If the scriptures of your religion contained the following phrases, indicate how you would interpret the phrases," this would imply Joan believes it possible that at one time during humankind's existence on Earth there was a flood that covered all land on Earth.

As her response to the prompt of, "If the text said, '... and the Earth stood still', you would interpret that as ..." Joan selected the response 'The Earth stopped revolving on its axis and rotating around the sun.' This implies Joan believes it is possible that at one point the Earth stopped revolving on its axis and rotating around the sun.

In response to the prompt concerning Biblical text, "If the text said, 'The world was created in 6 days', you would interpret that as ..." Joan selected the response, "The world was created in 6 24hr days." This implies that she believes the world was created in six 24hr periods. Joan's pre-mATSI score was 15 and her post-mATSI was 29. She indicated a strong agreement with the statement "When I hear the word 'science', I have a feeling of dislike." This changed to a 'weakly agree' on the post-mATSI.

On the pre-'science and religion conflict' survey, Joan indicated that she strongly agreed there is a conflict between science and religion. After the day of NOS discussion, then a day of watching the movie *Twister* (Bryce & De Bont, 1996) and analyzing it for NOS content, Joan rated feelings of conflict between science and religion at a two on a scale from zero to ten with zero being no conflict and ten being much conflict. After watching *Jurassic Park* (Kennedy & Spielberg, 1993) and *Gorillas in the Mist* (Guber & Apted, 1988), Joan's rating concerning conflict between

science and religion increased to a three. In the post science/religion conflict survey she changed to neutral from strongly agreeing with 'There is a conflict between science and religion,' and a 'neutral' that 'Science and religion are two completely separate things,' changed to agreeing.

Joan's statement concerning scientists' claims 'of when dinosaurs existed on Earth and when man existed on Earth,' although off subject was certainly more in line with science than Jan's: "... when they discuss if it's a reptile or bird then they need to give evidence on both sides so they can let the students decide on what they believe."

## CHAPTER 4: DISCUSSION

Change in attitude toward science and the perception of conflict between science and religion were seen to some degree by all students during the course of this instruction. The amount of change in most cases was minimal, which is not surprising for an event of three-week duration. Even the youngest participant in this student had accumulated 18 years of religious influence. None of the participants indicated to have previously tried to balance their science and religious beliefs. There was no evidence of any student at the end of the course being able to completely separate science and religion in the classroom.

These conflicts included:

- natural disasters having supernatural causes/direction
- conflict in understanding between people of science and people of religion
- possibility of life after death in a non-religious manner
- time difference between the existence of dinosaurs and humankind on Earth
- that humankind evolved from apes
- the ability of science to clone

Because of the methods of presenting these conflicts (within the framework of fictional movies and the students' own observations), the students were made aware of their cognitive dissonance without it being threatening. The students then had the opportunity to reflect and make 'private' journal entries concerning these conflicts. Then the conflicts were openly discussed as a classroom exercise.

One drawback to this method was some students thought this could be effectively used in an elementary school science setting. More effort should have been made by the facilitators of this course to emphasize that what was being undertaken in this college setting was not appropriate for a science course in the public school system. Another drawback was the infusion of science fiction into a science content curriculum without distinctly emphasized the distinction between science fiction and science.

## CHAPTER 5: CONCLUSION

The information derived from this study is limited by the narrowness of differences in religious beliefs among the participants. Because of the small number of participants and the brevity of the course, little can be extrapolated from the following observations:

- Cognitive dissonance between science and religion existed in each of these pre-service elementary school teachers.
- There was no indication from any of these students of having ever considered the conflicts between their religion and science. There was no discussion or other indication that these students had thought out the reason for their conflicts.
- There was no indication these students had any mechanism in place for dealing with their conflicts between science and religion.

The presentation of alternate ways of understanding our world is not acceptable in the science classroom. Our science classrooms are too diverse with students representing many different religious beliefs to present such ideas in a manner that would not cause offense. The purpose of public school is not to promote religious beliefs or to facilitate the debate of such beliefs. This is a unique problem for the science teacher. Promotion of religious beliefs as scientific is a problem the science teacher must be aware of and have the knowledge and training to avoid problematic episodes within the classroom.

Just as not all students are meant to be scientists, perhaps not all teachers are meant to teach science. Placing a teacher with strong verbatim scriptural

religious beliefs in a science classroom without the ability to separate those religious beliefs from the science content is problematic. Beginning teachers are faced with many problems and adjustments; it is not fair to send these teachers into the science classroom having never contemplated conflicts between science and religion.



## Appendix A

### VIEWS OF NATURE OF SCIENCE (VNOS D+)

Name: \_\_\_\_\_

Date:

#### ***Instructions***

- Please answer each of the following questions. You can use all the space provided and the backs of the pages to answer a question.
- Some questions have more than one part. Please make sure you write answers for each part.
- This is not a test and will not be graded. There are no “right” or “wrong” answers to the following questions. I am only interested in your ideas relating to the following questions.

1. What is science?

2. What makes science (or a scientific discipline such as physics, biology, etc.) different from the other subjects/disciplines?

3. Scientists produce scientific knowledge. Do you think this knowledge may change in the future? Explain your answer and give an example.

4. (a) How do scientists know that dinosaurs really existed?

(b) How certain are scientists about the way dinosaurs looked?

(c) Scientists agree that about 65 millions of years ago the dinosaurs became extinct (all died away). However, scientists disagree about what had caused this to happen. Why do you think they disagree even though they all have the same information?

5. In order to predict the weather, weather persons collect different types of information. Often they produce computer models of different weather patterns.

(a) Do you think weather persons are certain (sure) about these weather patterns?

(b) Why or why not?

6. What is a scientific model?

7. Scientists try to find answers to their questions by doing investigations / experiments. Do you think that scientists use their imaginations and creativity when they do these investigations / experiments? **YES NO**

a. If **NO**, explain why?

b. If **YES**, in what part(s) of their investigations (planning, experimenting, making observations, analysis of data, interpretation, reporting results, etc.) do you think they use their imagination and creativity? Give examples if you can.

8. Is there a difference between a scientific theory and a scientific law? Illustrate your answer with an example

9. After scientists have developed a scientific theory (e.g. atomic theory, evolution theory, etc.) does the theory ever change?

10.) Some claim that science is infused with social and cultural values. That is, science reflects the social and political values, philosophical assumptions, and intellectual norms of the culture in which it is practiced. Others claim that science is universal. That is, science transcends national and cultural boundaries and is not affected by social, political, and philosophical values, and intellectual norms of the culture in which it is practiced.

If you believe that science reflects social and cultural values, explain why and how. Defend your answers with examples.

If you believe that science is universal, explain how and why. Defend your answer with examples.

## Appendix B

Code Number = \_\_\_\_\_

The following questions are meant to determine your interpretations of religious texts (regardless of particular persuasion or denomination). The questions are generic in the sense that they are not meant to pertain to any given religion, however, they relate to the Christian bible as that is the religious source that the author is familiar with.

If the scriptures of your religion contained the following phrases, indicate how you would interpret the phrases.

1. If the text said, "There was a great flood that covered the Earth," you would interpret that as...

- a) There was a flood that covered all land on Earth
- b) There was a flood that covered a particular area of land of concern to the authors of the text
- c) There was not an actual flood; the context was used to make a point.

Other or explanation

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2. If the text said, "The world was created in 6 days." you would interpret that as...

- a) The world was created in 6 24hr days
- b) The world was created in 6 time periods of unknown length

- c) The world was created. How long it took is of no significance
- d) The world was created as a result of the big bang ... it was too difficult to explain this when this scripture was written.

Other or explanation

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3. If the text said "... and the Earth stood still." you would interpret that as...

- a) The Earth stopped revolving on its axis and rotating around the sun
- b) Not sure what happen but the Earth did not literally stand still

Other explain:

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4 As pertains to a deity (check the one statement which most nearly expresses your belief):

\_\_\_\_\_A. There is an infinitely wise, omnipotent Creator of the universe and of nature whose protection and favor may be supplicated through worship and prayer. God is God who listens to our prayers.

\_\_\_\_\_B. There is an infinitely intelligent and friendly Being, working according to nature through which he/she expresses His/Her power and goodness. There is the possibility of communication with this Deity in the sense that prayer may at least affect our moral conduct toward nature and toward our own place in the scheme of things.

\_\_\_\_\_C. There is a vast, impersonal, spiritual source or principle throughout nature and in man, which is not swayed by or communicated to through prayer.

\_\_\_\_\_D. The only power is natural law. There is neither a personal creator nor an intelligent Being. Nature is wholly indifferent to man. Natural law may be spoken of

force," but this in no way adds to or changes its character.

\_\_\_\_\_E. Because of our necessary ignorance in this matter, I neither believe nor disbelieve in God

Do you wish to explain your answer in any way?

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Immortality (check the position that best corresponds to your own view):

\_\_\_\_\_A. I believe in personal immortality, i.e., the continued existence of the soul as and separate entity.

\_\_\_\_\_B. I believe in reincarnation--the continued existence of the soul in another body.

\_\_\_\_\_C. I believe that a person's immortality resides merely in his influence upon his and upon social institutions.

\_\_\_\_\_D. I disbelieve in immortality in any sense.

Do you wish to explain your answer in any

way? \_\_\_\_\_

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<b>6. Do you believe that God can help you</b>				
a. by restraining people who could harm you (for instance, on the battlefield?)	Yes	Agree Sometimes	No	No Opinion
b. by forgiving your sins?	Yes	Agree Sometimes	No	No Opinion
c. by performing medical miracles?	Yes	Agree Sometimes	No	No Opinion
d. by having fellowship with you through prayer?	Yes	Agree Sometimes	No	No Opinion
e. by giving you power to cope with life's difficulties?	Yes	Agree Sometimes	No	No Opinion
<b>7. Do you think of God</b>				
a. as a Heavenly Father?	Yes	Agree Sometimes	No	No Opinion
b. as a Being outside yourself?	Yes	Agree Sometimes	No	No Opinion
c. as all-powerful?	Yes	Agree Sometimes	No	No Opinion
<b>8. Do you feel it necessary to abstain from certain "pleasures" (sex, liquor, overeating, etc.) for religious reasons?</b>	Yes	Agree Sometimes	No	No Opinion
<b>9. Do you feel that self-sacrifice raises the quality of the spiritual life?</b>	Yes	Agree Sometimes	No	No Opinion
<b>10. Have you ever had an experience wherein you felt "overwhelmed by God's presence," e.g., a religious conversion?</b>	Yes	Agree Sometimes	No	No Opinion
<b>11. Is your "philosophy of life" primarily concerned with religion?</b>	Yes	Agree Sometimes	No	No Opinion
<b>12. Can you accept the Bible as literal truth?</b>	Yes	Agree Sometimes	No	No Opinion
<b>13. Indicate your agreement with the following sayings abstracted from the writings of famous religious persons:</b>				
a. "Seek a convenient time to think on the benefits of God."	Yes	Agree Sometimes	No	No Opinion
b. "Life's most majestic experience is to have felt the Presence of God."	Yes	Agree Sometimes	No	No Opinion
c. "Verily we deceive ourselves by inordinate love of our flesh."	Yes	Agree Sometimes	No	No Opinion
d. "All other things in the world, save only to love God and serve Him, are vanity."	Yes	Agree Sometimes	No	No Opinion
e. "A man ought to strengthen himself so that he needeth not to seek any consolation from the world outside."	Yes	Agree Sometimes	No	No Opinion
f. "God saves man by Grace."	Yes	Agree	No	No Opinion

		Sometimes		
<b>14. A person feels better after confessing his sins to God (or God's representative).</b>	Yes	Agree Sometimes	No	No Opinion

<b>15. I believe in the existence of a just and merciful personal God.</b>	strongly disagree	disagree	agree	strongly agree
<b>16. I believe God created the universe.</b>	strongly disagree	disagree	agree	strongly agree
<b>17. I believe the Bible is the unique authority for God's will.</b>	strongly disagree	disagree	agree	strongly agree
<b>18. I believe that God has a plan for the universe.</b>	strongly disagree	disagree	agree	strongly agree
<b>19. My religious beliefs are what lie behind my entire approach to life.</b>	strongly disagree	disagree	agree	strongly agree
<b>20. I try hard to carry my religion over into all areas of my life.</b>	strongly disagree	disagree	agree	strongly agree

<b>21. There is a conflict between science and religion.</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<b>22. Science and Religion are two completely separate things.</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<b>23. Science explains the 'why' of our existence</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<b>24. Religion explains the 'why' of our existence</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<b>25. The purpose of Science is to get at the 'truth'.</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<b>26. The 'truth' is in Religion</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<b>27. Everything necessary for humankind's existence was spelled out in religious scripture</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree



<b>28. Science compliments Religion</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<b>29. Religion compliments Science</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<b>30. I have no problems separating my religious beliefs from my scientific understanding.</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

## Appendix C

### Demographic Information

Name: \_\_\_\_\_ First language: \_\_\_\_\_  
 Sex: Male Female Age: \_\_\_\_\_  
 Race: \_\_\_\_\_ Years in US: \_\_\_\_\_  
 Classification: Freshmen Sophomore Junior Senior

ATSI ITEM STATEMENTS	STRONGLY AGREE	AGREE	WEAKLY AGREE	WEAKLY DISAGREE	DISAGREE	STRONGLY DISAGREE	DO NOT UNDERSTAND
1. Science is something that I enjoy very much.	1	2	3	4	5	6	
2. I do not very well in science.	1	2	3	4	5	6	
3. Doing science labs or hands-on activities is fun.	1	2	3	4	5	6	
4. I feel at ease in a science class.	1	2	3	4	5	6	
5. Science is easy for me.	1	2	3	4	5	6	
6. When I hear the word “science,” I have a feeling of dislike.	1	2	3	4	5	6	
7. I would like to spend less time in school studying science.	1	2	3	4	5	6	
8. I usually understand what we are talking about in science.	1	2	3	4	5	6	
9. I do not like anything about science.	1	2	3	4	5	6	
10. No matter how hard I try, I cannot understand science.	1	2	3	4	5	6	
11. I feel tense or upset when someone talks to me about science.	1	2	3	4	5	6	
12. I often think, “I cannot do this,” when a science assignment seems hard.	1	2	3	4	5	6	
13. It does not disturb or upset me to do science assignments.	1	2	3	4	5	6	
14. I would like a job that does not use any science.	1	2	3	4	5	6	
15. I enjoy talking to other people about science.	1	2	3	4	5	6	
16. I enjoy watching a science program on television.	1	2	3	4	5	6	
17. I am good at working science labs and hands-on activities.	1	2	3	4	5	6	
18. Working with science upsets me.	1	2	3	4	5	6	
19. I remember most of the things I learn in science class.	1	2	3	4	5	6	
20. It makes me nervous to even think about doing science.	1	2	3	4	5	6	
21. It scares me to have to take a science class.	1	2	3	4	5	6	
22. I have a good feeling toward science.	1	2	3	4	5	6	
23. Science is one of my favorite subjects.	1	2	3	4	5	6	
24. If I do see how to do a science assignment right away, I never get it.	1	2	3	4	5	6	

## Key for ATTITUDE TOWARD SCIENCE INVENTORY

### Version A

Anxiety toward Science = 4\*, 6, 11, 13\*, 18, 20, 21, 22\*

Self-concept of Science = 2\*, 5, 8, 10\*, 12\*, 17, 19, 24\*

Enjoyment of Science = 1, 3, 7\*, 9\*, 14\*, 15, 16, 23

The \* indicates that the score will be reversed because the statements were worded in the negative. Higher numerical scores reflect more positive attitudes in all areas except anxiety where a lower numerical score reflects a more positive attitude (less anxiety).

## Appendix D

### Ordeal by cheque

BY WUTHER CRUE

LOS ANGELES, CALIF. Apr. 18<sup>th</sup> 19 10 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF City Bicycle Co. \$ 52.50  
Fifty two ———— 50/ DOLLARS

Lawrence Exeter, Sr.

LOS ANGELES, CALIF. Aug 30<sup>th</sup> 19 03 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF Grocie Lander Baby Shoppe \$ 48.50  
One hundred + forty eight ———— 50/ DOLLARS

Lawrence Exeter

LOS ANGELES, CALIF. Aug 26<sup>th</sup> 19 15 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF Columbia Military Acad. \$ 2,150.00  
Twenty one hundred + fifty ———— XX DOLLARS

Lawrence Exeter, Sr.

LOS ANGELES, CALIF. Sept 2<sup>nd</sup> 19 03 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF Hollywood Hospital \$ 100.00  
One hundred ———— XX DOLLARS

Lawrence Exeter

LOS ANGELES, CALIF. Sept 3<sup>rd</sup> 19 21 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF Hollywood Cadillac Co. \$ 3,885.00  
Thirty eight hundred + eighty five ———— XX DOLLARS

Lawrence Exeter, Sr.

LOS ANGELES, CALIF. Oct 3<sup>rd</sup> 19 03 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF Dr. David M McCoy \$ 475.00  
Four hundred + seventy five ———— XX DOLLARS

Lawrence Exeter, Sr.

LOS ANGELES, CALIF. Sept 7<sup>th</sup> 19 21 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF Wilshire Auto Repair Service \$ 288.76  
Two hundred + eighty eight ———— 76/ DOLLARS

Lawrence Exeter, Sr.

LOS ANGELES, CALIF. Dec 19<sup>th</sup> 19 03 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF California Toyland Co. \$ 83.20  
Eighty three ———— 20/ DOLLARS

Lawrence Exeter, Sr.

LOS ANGELES, CALIF. Oct 15<sup>th</sup> 19 21 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF Stanford University \$ 339.00  
Three hundred + thirty nine ———— XX DOLLARS

Lawrence Exeter, Sr.

LOS ANGELES, CALIF. Oct 6<sup>th</sup> 19 09 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF Palisades School for Boys \$ 1,250.00  
Twelve hundred + fifty ———— XX DOLLARS

Lawrence Exeter, Sr.

LOS ANGELES, CALIF. June 1<sup>st</sup> 19 23 No. \_\_\_\_\_

**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD

PAY TO THE ORDER OF Miss Daisy Windsor \$ 25,000.00  
Twenty five thousand ———— XX DOLLARS

Lawrence Exeter, Sr.

LOS ANGELES, CALIF. July 16, 19 27 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Parisian Gown Shoppe \$25.00  
Nine hundred, twenty five DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. Aug. 30, 19 29 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Tony Spagoni \$126.00  
One hundred, twenty six DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. Dec. 1, 19 27 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Anita Lingerie Salon \$750.00  
Seven hundred, fifty DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. May 25, 19 30 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF University Club Florists \$87.00  
Eighty seven DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. April 1, 19 28 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Parisian Gown Shoppe \$1,150.00  
Eleven hundred, fifty DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. May 28, 19 30 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Broadway Diamond Co. \$575.00  
Five hundred, seventy five DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. Nov. 1, 19 28 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Moderne Sporte Shoppe \$562.00  
Five hundred, sixty two DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. Nov. 13, 19 30 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Miss Flossie Wentworth \$50,000.00  
Fifty thousand DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. July 1, 19 29 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF The Bootery \$45.25  
One hundred, forty five <sup>25</sup>/<sub>100</sub> DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. Nov. 14, 19 30 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Wall Smith, attys. at law \$525.00  
Five hundred, twenty five DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. Aug 23, 19 29 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Tony Spagoni \$126.00  
One hundred, twenty six DOLLARS  
Lawrence Epeter, Jr.

LOS ANGELES, CALIF. Nov. 15, 19 30 No. \_\_\_\_\_  
**HOLLYWOOD STATE BANK** 90-984  
6801 SANTA MONICA BOULEVARD  
PAY TO THE ORDER OF Mrs. Lawrence Epeter, Jr. \$5,000.00  
Five thousand DOLLARS  
Lawrence Epeter, Jr.

## Appendix E

Your Name - \_\_\_\_\_ Date - \_\_\_\_\_

Nature of Science Portrayed in Film - \_\_\_\_\_

Nature of Science Aspect	Time/Notes
Tentative	
Creative	
Observation & Inference	
Subjective (theory-laden)	

Theories & Laws	
Social & Cultural	
Empirically Based	

Your Name - \_\_\_\_\_

Date - \_\_\_\_\_

Science Content Portrayed in Film -

Science Content Portrayed Accurately	
Science Content Portrayed Inaccurately	
Unsure of Science Content Accuracy	



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