

Acid Rain in Europe 1979-1989

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This is a course about authority and conflict. It is also a course about science. Since conflict is at the heart of all science, it is appropriate that we set this science course in points of conflict. Scientists argue with each other constantly. They propose new theories and try to overturn the theories of others. They do this using the best observational evidence they can muster in some cases. They also do it without any evidence and based entirely on mathematics, intuition, and logic. The work of Einstein and that of the founders of Quantum Mechanics are examples of theories which had little experimental evidence when first proposed. Thomas Kuhn has observed that science progresses in a very non-linear fashion. There is a long period when the ruling paradigm is accepted and scientists attempt to fix it as data accumulates that challenges it. Then suddenly, a new idea arises that turns everything on its head. In most cases, the old paradigm is abandoned and the new one becomes accepted for a long period. Evolutionary theory, relativity, and quantum mechanics are all examples of these scientific revolutions. They will form the scientific basis for the second half of this course.

The first half of the course will deal with a theory in environmental science, that air pollution was causing damage to forests and waterways. There are many examples of cases where a single scientist or a small group proposes such a theory to relate a specific form of pollution to an environmental problem. The observation by Shelly Roland and colleagues that chlorine destroyed ozone led to a theory that the Freon in aerosol cans, plastic foams, and other uses would cause serious damage to the earth's ozone layer. It required almost 20 years for the evidence to build to the point that political action was taken to curtail the problem. It will take another hundred years to erase the damage. Other examples include the acid rain problem which is the subject of this course and the issue of global warming. Other similar cases involve the problem of pesticides which was popularized by Rachael Carlson in *Silent Spring*, and the recent discovery of the hormonal effects of various chemicals including some in bottled water, which is still an active research topic.

Two reacting games will form the setting for the conflict in this course. . In the first game, the conflict is between ideas of the environment and how to protect it. It also takes on economic and political overtones. The issue of authority still is important. How authoritative are the findings of science and what do we do when they demand us to change our behavior? The understanding of the fundamental relationship between humanity and the world we inhabit is also a central question. This will be examined through readings in environmental philosophy. In the *Evolution in Kansas* game, this conflict is between ancient texts and long established "truth" on one side and the finding of "modern science" on the other side. It is important to note that both sides of the issue claim to have observations and logic on their side. So the decision of who is correct is not as simple as it may seem. We will explore this with labs and demonstrations which can be used to support both sides of the argument in some cases

The *Acid Rain in Europe* game begins in the late 1970's with a series of international meetings on acid rain and the air pollution which causes it. This was a time of strong environmental movements in conflict with established political and industrial cultures which wished to maintain the status quo. It was also a time of intense conflict between the Soviet block and the West. All of these factors will play out in the game. You will need to learn a bit about air pollution and the chemistry of acids. It will also be necessary to examine basic philosophical and economic approaches to the environment and the science of air pollution.

The *Evolution in Kansas* game has as its overall theme the conflict between the Biblical story of creation and a "scientific" story by Darwin and his antecedents and the cosmology of the Big Bang. These may or may not be viewed as being in conflict, depending on your interpretation. Both sides claim they have observations which support their theories. How does one decide which is correct? On what authority are these choices made. In Kansas in 1999, the Kansas State Board of Education (KBOE) voted to eliminate the teaching of macro-evolution and of the Big Bang cosmology from the school curriculum of the state. This is a continuation of the conflict between Galileo and the Church. There are issues in the controversy about religious fundamentalism in the modern world and its impact on all of us and on the practice of science. Ironically, evolutionary theory actually begins with Aristotle. The idea of the Big Bang was first proposed by a scientist who became head of science for the Vatican. During this game, we will explore evolutionary theory beginning through the writings of Charles Darwin and then through the eyes of a modern biochemist who challenges the sufficiency of Darwin's theory from a purely atheistic point of view. We will also explore modern cosmology of the Big Bang and the scientific challenges and alternatives to it. In the end, you must decide what to teach the school children of Kansas.

In order to really understand the science which underlies these Reacting games, this course will include several laboratory and demonstration activities. We will experiment, observe, and attempt to make sense of our observations in various ways. Approximately two weeks of class will be spent in some form of direct scientific observation. Also, like scientists of all time, you will occasionally need to use mathematics to make sense of your observations. We will also need to do some simple arithmetic to evaluate the costs and benefits of pollution. The mathematics required is nothing more extensive than you need to keep track of your taxes or operate a small business.

The quantitative component of this course will be a valuable introduction to tools which you will find useful in other areas of your life. Specifically, you will learn to use Microsoft EXCEL as a special calculator for organizing your observations, for doing simple arithmetic, and for making graphs and tables to present your data in an organized fashion. Making and interpreting graphs is a valuable quantitative skill and EXCEL is used widely in all areas of public life to deal with data. So whether you become a CEO, a Senator, a physician, a football coach, or a Judge, you need to know a bit about how Excel organizes data.

Research and Writing are also important components of the Focus program and of this course. Each student will write a minimum of 10 pages as part of their work in each game. (With 2 games that means at least 20 pages total) Students who fall short of this minimum requirement will have their grade reduced. This writing will require research into primary materials to support the arguments you wish to make. The better your research, the better you should be able to support your arguments and the more arguments you will be able to make.

You will also do a final research project on some aspect of the science we have covered. This project will begin with a review of the literature available on the topic. After you have assembled a satisfactory list of references, you will prepare an Annotated Bibliography. This will include a brief summary of the pertinent aspects of each reference and how it relates to the overall topic you are going to cover in your paper. After your Annotated Bibliography is approved, you will begin preparing your final research paper. With the approval of the professor, you may choose a format for your final project other than a formal paper. Some flexibility will be allowed to encourage creativity on your part. You might wish to write a short play or even a fictional work that addressed the topic of your research in an insightful manner. You could even do a movie. Science is about creative ideas and creativity in fulfilling this requirement is encouraged.

Evaluation

Writing and Research		60%
Kansas	22.5%	
Acid Rain	22.5%	
Final Project	15%	
Lab/Demonstration (reports, etc)		10%
Participation		30%

Final Project Topics

Your research project can be on any aspect of modern science that is relevant to either game. Some possibilities are listed below, but you are welcome to explore other topics that come up and interest you.

Cosmology – the Big Bang

Cosmology – Alternatives to the Big Bang (String Theory, Branes theory, etc.)

Evolution – Darwin’s theory and symbiosis in all of its facets

Quantum Mechanics –

Grand Unified theories or everything

Origin of Life – efforts of science to understand the earliest stages

Air pollution and the success of efforts to control it

Global warming – what causes it and what can be done about it.

Organic foods or other areas of environmental concern can also be considered including specific pollutants like pesticides, hormones, hormone mimics, and genetic engineering.

Outside Activities

1. Pizza and a Movie – viewing of Mindwalk

I will cancel one class to compensate for attendance at the movie.