

## Contemporary Issues in Science:

### Forging a Link between General Science Education and Civic Responsibility

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### Abstract

We are developing a new general education course "Contemporary Issues in Science." The objective is to enable non-science majors to investigate the science associated with current civic issues relevant to their lives. In the pilot version, we focus on issues associated with the production, delivery, and consumption of energy. Students learn about the science of nuclear and solar energy as well as fossil fuels and biofuels. Students participate in three case studies in which they, as citizens, express and support their position on a specific energy-related issue typical of those that arise in local, state, national, or global forums. As they prepare for these discussions, we guide them toward useful source materials and help them learn to evaluate sources for reliability. Student activities also include group problem-solving using instructor-designed computer modules and lab activities that illustrate the relevant scientific concepts. (Lab activities generally use common materials rather than esoteric chemicals or specialized equipment.) Preliminary results indicate a significant improvement in student attitude toward science although not necessarily an improved understanding of science.

### SENCEP and MTSU: Common Goals

The course "Contemporary Issues in Science" was developed to address goals for MTSU general education science and the goals of the NSF-funded program Science Education through New Civic Engagements and Responsibilities (SENCEP). These goals are closely aligned:

*"Issues in today's world require scientific information and a scientific approach to informed decision making. Therefore, the goal of the Natural Sciences requirement is to guide students toward becoming scientifically literate. This scientific understanding gained in these courses enhances students' ability to define and solve problems, reason with an open mind, think critically and creatively, suspend judgment, and make decisions that have local or global significance."*

MTSU 2005-2007 Undergraduate Catalog  
The SENCEP program "directly responds to the need for high quality science and quantitative education. We believe that some degree of scientific literacy is a requisite part of an education that seeks to develop abilities in critical thinking, analysis, numeracy, and inquiry that involves discovery and exploration. We believe that such competency in scientific reasoning and its related sensibilities are necessary for all leaders in a robust democracy. SENCEP course models teach "through" science to the complex, capacious, and unsolved public issues that have significant "scientific" dimensions and where some comprehension of science would greatly improve decision making in both public and personal spheres."

### Our Goal

The primary goal for our students is that, by the end of the course, they will be able to formulate and communicate clearly a personal position regarding the use of a particular form of energy in terms of its scientific, economic, environmental, social, and moral implications, basing their position on sound science and a synthesis of information obtained from a variety of resources.

### Course Structure: Energy Modules

Students meet three times each week, once in a common 85 minute lecture class and twice in smaller (max 24 students) 110 minute activity periods. The course content is divided into three modules, each of which focuses on a different energy source. Modules all incorporate the following student activities:

- Lectures and tests
- Quizzes over assigned reading
- Small group problem-solving using computers
- Experiments illustrating or exploring concepts
- Library and Internet research
- Small group discussion of energy-based issues
- Oral presentations (at module completion) by students using energy based case studies.

### Sample Module: Solar Energy

**Builds on concepts introduced previously:**

- Conservation of Energy
- Heat and Temperature
- Atoms, Molecules, and Nuclei
- Nuclear Reactions (source of sun's energy)

**Lectures:**

- Solar Energy Overview (including sun's energy source)
- Photovoltaics
- Radiant Energy and Earth's Atmosphere Sustainability

**Computer Problem Sets:**

- Electromagnetic Spectrum
- Interaction of Radiation with Matter
- Photovoltaics
- Greenhouse Effect

**Lab Activities:**

- Upon Reflection (Reflection of Light by Materials, Albedo)
- Sunstuff (Absorption of Ultraviolet Radiation by Sunscreens and Sunglasses)
- Solar Homes (Effect of thermal mass on temperature stability)
- Greenhouse Effect

**Solar Energy Case Study:**

How should your senators and representatives vote on proposed legislation that would require utility companies to establish a Renewable Energy Portfolio that provides 15% of the company's power?

### Science content: Diverse systems, common concepts

An explicit goal of MTSU's general education science program is to demonstrate that scientific concepts apply universally, to diverse systems: Our course focuses on the application of a relatively small number of concepts as applied to different situations. Examples include

**Conservation of energy:**

- solar to thermal,
- solar to electric,
- chemical to thermal to electric,
- nuclear to thermal to electric

**Interaction of radiation with matter:**

- absorption of UV radiation by stratospheric ozone,
- absorption of IR radiation by greenhouse gases,
- absorption of visible radiation by solar cells,
- absorption of gamma rays by nuclei and atoms

**Relationship between heat transfer and temperature change of matter:**

- Heating fluids with solar energy
- Heating fluids with fossil fuels



### SENCEP Research

Our students are non-science majors with varying backgrounds in math and science. Typically they are freshmen or sophomores, both traditional and non-traditional in terms of age. The majority begin the course with negative attitudes toward all science classes.

Research questions:

*Will students' attitudes change about science using a SENCEP approach in a general education physical science course?*

*Will learning of physical science change using a SENCEP approach in course?*

Instruments (in addition to course grades) used for course evaluation:

SENCEP SALG, Test of Science-Related Attitudes (TOSRA), One-Minute Response Questions, Interviews about "Learning"

### Preliminary Results

Based on data obtained from 30 students in two sections of the pilot course offering (Spring 2007):

- Anecdotal evidence indicates more student interest in the course topics.
- There is no overwhelming improvement in student achievement (grades) in physical science.
- From TOSRA, the t-test showed that there is significant difference between the SENCEP and the traditionally taught course on the **post** survey "score" with  $t_{92} = 2.84$ . The p-value was calculated to be 0.006. The mean for the SENCEP taught course is 3.03 and for the traditionally taught course is 2.88.
- From TOSRA, there is no significant difference between the SENCEP and traditionally taught course on the **pre** survey "score" with  $t_{94} = 0.29$ . The p-value was calculated to be 0.77.

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