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ABSTRACT

This paper examines issues that K-12 science and social studies teachers need to keep in mind when teaching about nuclear power. The information needs to be presented in as objective a manner as possible. Science needs to become more social oriented. Team teaching should be encouraged. Elementary and secondary inservice teacher education is needed. When designing a class about nuclear energy, teachers need to be aware that accuracy of informational content needs to be considered from two perspectives. These perspectives are the correctness of the information and the intellectual honesty with which this information is presented. Teachers should also know the major issues surrounding the nuclear debate and some of the arguments on both sides of the issues so that information and activities can focus on these major points. The paper examines six of these major issues and discusses what nuclear advocates and adversaries say concerning them. The issues are nuclear safety, health impact, nuclear waste management, economics of nuclear power, the need for nuclear power, and nuclear proliferation. In developing a strategy for presenting these nuclear issues in the classroom, there are a variety of available resources that the classroom teacher can use. The paper does not describe the resources. (RM)

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Nuclear Power in the Classroom: A Union of Science and Social Studies Education

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Nuclear power in the classroom: a union of science and social studies education

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ABSTRACT

Science and technology, which once brought the United States and other industrialized countries of the world unprecedented energy resources and financial rewards, have begun to realize that politics and not the scientific method will determine the quality of life in the 21st century. Educators find it difficult to present nuclear power in a way that will allow students to make informed decisions and judgements on this issue. There is a need for unity in the science and social science fields, and presentation of material in an objective way incorporating both scientific and sociological aspects. Students need to make critical thinking and logic a standard in dealing with conflicting information. Major issues and arguments on nuclear power are presented, with possible classroom activities and resources cited.

A NEED FOR UNITY IN A CHANGING WORLD

Science and technology, which once brought the United States and other industrialized countries of the world unprecedented energy resources and financial rewards, have begun to realize that politics and not the scientific method will determine the quality of life in the 21st century. Nuclear power, as one source of energy for the past 25 years since the development of the first commercial reactor at Shippingport, Pennsylvania, has become a volatile issue in the United States and worldwide.

What responsibility do educators have in presenting energy issues such as nuclear power in the classroom? This paper will focus on nuclear power, the challenges it presents to educators at all levels in the field in preparing and presenting information in the classroom. This paper will cover two specific disciplines--science and social studies.

Nuclear power in the classroom has had a relatively short history in the annals of education and has been traditionally considered a part of the science curriculum for decades.

Historically, science educators, according to the results of a five year study by the National Science Foundation (NSF)[1], have reacted to the task of teaching science and technology from a "purist" point of view. This view as NSF reported caused students to "not learn the relationship between science and technology, hence as future citizens they were unaware of the roles that research and development play in an industrial nation and trade-offs and side effects that would affect them individually and collectively."[2] This was evident with the curriculum projects of the 1960s. The interest during that decade was to train youngsters to become sophisticated professional scientists who could advance technologies related to nuclear energy, space exploration, and oceanography that would enhance defense systems and national security.

In the social studies, however, nuclear power has not been given much space in its curriculum until recently. College and high school textbooks spent most of their space on nuclear power's relationship to weaponry, submarine and warship utilization, and other defense or military history including the devastation at Hiroshima and Nagasaki.

Historically, the social studies field found itself also responding to "governmental intervention and the pressure to make the public education system an instrument of social reform..."[3] Besides governmental pressures dictating curriculum, other forces were at work in our school curricula such as "currents and counter currents including liberal and conservative ideologies, innovators, and traditionalists, accountability adherents, promoters of management by objectives, elitist versus populist philosophies, and advocates of technological applications to education."[4] What then has this done to educators in terms of bringing controversial issues into the classroom?

Social studies educators reported in the NSF study that dealing with controversial issues in the classroom is a particularly significant problem. This problem has been based on their sensitivity to local feelings and values--a sense that communities expected their teachers would "pass on knowledge accumulated by others, rather than encouraging students to raise creative challenges or think critically."[5] This sensitivity to controversial issues has important ramifications to the role of "socialization" in our schools. A problem exists when a controversy surfaces in identifying whose norms or goals in respect to nuclear energy would be presented. If social studies has been identified as "perhaps the closest thing to 'value education' which exists in the regular curriculum of the public schools today"[6], then the role and responsibility of the educator in presenting the nuclear power information in an objective manner is paramount.

The task then of presenting materials in an objective a manner as possible and making science more social oriented seems enormous. The key, however, to enacting objectivity through increased cognitive skill development and becoming more socially oriented involving the affective domain of learning may be found in greater articulation of programs encouraging team teaching, and inservice training throughout elementary and secondary education.[7] Through an articulated program and a network of educators at all levels, curriculum infusion of energy education programs such as nuclear power, can make the "interconnection" possible.

Dealing with Conflicting Information

When educators are confronted with conflicting information on nuclear issues, the task of designing a class or series of classes that will increase students' understanding of the nuclear issues may appear to be impossible. When designing a class on controversial issues the educator must be aware that accuracy of informational content needs to be considered from two perspectives. These perspectives are the correctness of the information and the intellectual honesty with which this information is presented.[8] The correctness of information is relatively easy to verify through experts from the relative disciplines. For example, the average background dose rate to an individual in the U.S. is about 100 millirems per year, and this information can be confirmed easily from many sources. However, the perspective of intellectual honesty of informational content is more subtle. Students must be made aware of the fact that some of the information presented is tentative, incomplete or based upon certain assumptions which are unproved. An example of this is the area of low level radiation. The student hears from one "expert" that low level radiation is not hazardous and hears from another "expert" that low level radiation is hazardous.

The intellectually honest answer to the questions of the health hazards of low level radiation is that the information available in this area is incomplete.[9] After being informed of this fact, students should then be allowed to evaluate the evidence and premises that lead to the conclusion that low level radiation is either hazardous or not. At this point students must apply critical thinking guidelines and the use of logic. For example, they can be asked, "Have arguments presented on either side of the nuclear issue contained information fallacies of relevance or ambiguity such as appeal to pity, hasty generalization, begging the question, or fallacy of accent?"[10]

Major Issues and Arguments

Before designing a class or series of classes on nuclear issues the classroom teacher should know the major issues surrounding the nuclear debate and some of the arguments on both sides of the issues so that information and activities can focus on these major points. Major issues in this case are defined as those issues which are most frequently debated in the United States but are relevant to the rest of the world as well.[11]

Issue #1: Nuclear Safety[12]

Basis for Concern: In the fission process large amounts of radioactive fission products are produced. Safety systems have been designed in order to prevent the accidental escape of these fission products into the environment. The public concern is whether or not these systems will work and protect the public from significant radiation exposure due to a serious commercial reactor accident.

Nuclear Advocates Say:[13] The excellent safety record of the nuclear power reactors to date demonstrates the safety of nuclear power. Even with the Three Mile Island accident (the most serious commercial nuclear reactor accident) no member of the public has ever been killed or injured because of a nuclear power plant accident. Improvements in safety designs over the years, with redundant backup systems and defense in depth concepts used in reactor safety systems, makes the probability of a major accident extremely small as demonstrated in WASH-1400.[14]

Nuclear Adversaries Say:[15] Even though there has not been a catastrophic nuclear plant accident, there have been many close calls and its only a matter of time before one of these problems result in a single nuclear accident that could result in thousands of deaths and injuries and contaminating a land area the size of Maryland. Small deficiencies in many areas of a nuclear plant combine to make the system unsafe. The numbers given by WASH-1400 for long term latent cancers and genetic defects for a particular accident were underestimated by a factor of 50.[16]

Issue #2: Health Impact

Basis for Concern: There are several different operations in the production of electricity from nuclear power that can result in radiation exposure to members of the public. This series of operations is referred to as the Uranium Fuel Cycle which includes mining and milling, fuel enrichment, fuel fabrication, power production, and radioactive waste disposal.

Nuclear Advocates Say: Radiation exposure to the public from nuclear power production is small when compared to exposure from natural background radiation. The health effects of nuclear power are less than the health effects of other energy alternatives such as coal.

Nuclear Adversaries Say: There is no safe level of radiation exposure. The health comparisons between nuclear and coal-fired generators focus on emissions from the stack of coal-fired generators ignoring hazardous radiation releases from other parts of the fuel cycle.

Issue #3: Nuclear Waste Management

Basis for Concern: Radioactive waste is the inevitable by-product of the generation of electricity by nuclear reactors. The intensity of the radioactivity present is very high. Immediately at reactor shutdown, a ton of spent fuel contains about 300 million curies of activity. Commercial waste is presently being stored as spent fuel assemblies, most of it in water cooled facilities at the reactor sites where it was generated.

Nuclear Advocates Say: There are several adequate technical alternatives for storage of nuclear waste. If the spent fuel now being stored at the reactor sites were reprocessed, the more troublesome and longer lived radioactive species could be spearated and reused for energy production, while the volume of the radioactive waste material to be stored would be reduced considerably. The most suitable repository for long term radioactive waste storage is in stable geologic formations which are known to have been unchanged for thousands or millions of years.

Nuclear Adversaries Say: There is no agreed upon safe way to isolate radioactive materials from the environment for thousands of years, a time span longer than human civilization. Nuclear storage facilities have had a hard time protecting wastes from the environment for even a decade. Radioactive wastes are a dangerous end to the fuel cycle, they are toxic. Once released into the environment they contaminate land and water virtually "forever."

Issue #4: Economics of Nuclear Power

Basis for Concern: The consumer is experiencing increases in the costs of nuclear power plant construction and electricity produced by nuclear power plants.

Nuclear Advocates Say: The cost of all forms of energy is growing and nuclear power is still the best bargain for producing electricty in most parts of the country when all factors are considered. Costs for nuclear power could be reduced if regulatory delays were reduced and if the Nuclear Regulatory Commission would streamline the licensing process for nuclear power plants.

Nuclear Adversaries Say: The cost of nuclear power is growing at a faster rate than other energy alternatives due to the rising cost of construction and operation, and low capacity factors. The nuclear industry would not have developed without enormous government subsidies.

Issue #5: Need for Nuclear Power

Basis for Concern: Conservation and other energy sources such as solar, geothermal, fusion, etc. may be able to replace nuclear power. Presently it is unclear whether or not these sources will be able to provide enough energy to satisfy energy needs in the face of diminishing fossil fuel resources.

Nuclear Advocates Say: Although conservation will help reduce energy growth there still will be a need to further develop existing energy technologies such as nuclear power to provide energy needs while other energy technologies are being developed. Even with a large national committment to new energy technology research it will take 20-30 years for successful development and commercialization.

Nuclear Adversaries Say: There is no need for nuclear power. With immediate changes in America's energy wasteful lifestyles enough energy can be saved to make nuclear power unnecessary. If nuclear power development were curtailed or stopped entirely and the same funding applied to development of alternatives, such as solar energy, these energy alternatives could begin producing a significant part of the U.S. energy supply in a very short period of time.

Issue #6: Nuclear Proliferation

Basis for Concern: Nuclear reactors use fissionable uranium and produce plutonium. If properly processed, these materials can be used to produce nuclear weapons.

Nuclear Advocates Say: In today's world any country that wants to develop a nuclear weapon can do so with or without a commercial nuclear power industry. Thus far, nations who have developed nuclear weapons have done so by easier and faster means than processing fuel from a commercial reactor. Participation in international agreements and having adequate amounts of energy available for economic growth are the only ways of reducing the spread of nuclear weapons.

Nuclear Adversaries Say: The spread of commercial nuclear power technology can only lead to more countries developing nuclear weapons. Due to the proliferation of atomic reactors, about 30 countries have plutonium that could be used in bombs. Half of these countries have refused to sign the 1970 International Treaty on Non-Proliferation, thus exempting them from even the limited oversight of the IAEA.[17]

In addition to the major issues, some other isses that energy educators should be aware of which often become part of the nuclear debate include nuclear reactor siting, Price-Anderson Act,[18] terrorism, decommissioning of nuclear reactors, availability of uranium supplies, transportation of nuclear materials, breeder reactors, licensing and regulation of nuclear power plants and other nuclear facilities, morality of nuclear power, "hard" versus "soft" energy technologies and issues of importance to the local community.

Classroom Resources

In developing a strategy for presenting these nuclear issues in the classroom there are a variety of available resources that the classroom teacher can use. These resources vary from a one year course on nuclear science[19] to classes designed by other teachers, such as debates,[20] simulations,[21] creative dramatics,[22] and others.[23] This points to the important role the teacher must play in this entire process, including other people who impact on him or her at different stages of that role such as, teacher-educators, administration, support supervisory people, print and non-print producers/publishers of resource materials, inservice training personnel, teacher-peers, parents and the students. It is the teacher who will really make the difference in students, "who are for any one year most dependent on what that teacher believes, knows, and does--and doesn't believe, doesn't know, and doesn't do. For essentially all...learned in the school, the teacher is the enabler, the inspiration, and the constraint."[24]

[1] What are the Needs in PreCollege Science, Math, and Social Science? Views from the Field, National Science Foundation: Office of Program Integration, Washington, D.C., Vol. 8, SE 80-9, 1980.

[2] Reference 1, p. 68.

[3] Reference 1, p. 59.

[4] Reference 1, p. 66.

[5] Reference 1, p. 8.

[6] Reference 1, p. 128.

[7] Reference 1, pp. 68, 69, 130.

[8] Audrey Champagne and Leo E. Klopfer, in Proceedings of the Sixth Annual Conference, Council for Educational Development and Research (U.S. Dept. of Energy, Technical Information Office, 1977) p. 182-183.

[9] The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980 (National Academy Press, Washington, D.C., 1980) p. 1.

[10] A review of logical fallacies contained in an introductory text on logic will be extremely helpful in analyzing arguments on the nuclear issues, such as, I. M. Copi, Introduction to Logic, 3rd ed., (Macmillan, New York, 1969).

[11] Nuclear Power Issues and Choices, Report of the Nuclear Energy Policy Study Group (Ballinger, Cambridge, 1977) p. 1.

[12] For purposes of this discussion in this paper, a format of a statement of the issue followed by advocates' arguments and then adversaries' arguments has been arbitrarily established with no intent to make either set of arguments more favorable by its order in the paper.

[13] Nuclear advocate arguments can be found in a variety of books and articles, for example, F. Hoyle and G. Hoyle, Commonsense in Nuclear Energy (Freeman, San Francisco, 1980).

[14] "Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," 9 Vols., U.S. NRC Report, WASH-1400, NUREG-75/014, October, 1975.

[15] Nuclear adversary arguments can be found in a variety of books and articles, for example, A. Gyorgy, No Nukes: Everyone's Guide to Nuclear Power (South End Press, Boston, 1979).

[16] Reference 15, p. 115.

[17] International Atomic Energy Agency.

[18] When nuclear power began to emerge in the U.S., Congress was concerned with providing insurance protection to the public and limiting the liability of the nuclear industry in the event of a major nuclear accident. To accomplish these purposes, the Price-Anderson Act was enacted in 1957 and renewed for the second time in 1976.

[19] See, for example, Nuclear Science (Pennsylvania Department of Education, 1977).

[20] See, for example, P. B. Hounshell and G. M. Madrazo, Jr., "Debates: Verbal Encounters in the Science Classroom", School Sci and Math 79 (8), 690-94 (1979).

[21] See, for example, P. Maxey, "Teaching About Nuclear Power: A Simulation" Soc Stud Rev 19 (2), 43-46 (1980).

[22] See, for example, I. Blair-Clough and B. Wheeler, "In the Shadow of Three Mile Island", Instructor 89 (2), 115-16, 118, 120 (1979).

[23] See, for example, R. Parker, "Radiation and the Environment: A Relevant Course on a Topical Subject", J. Chem. Ed. 54 (7) 435 (1977).

[24] Reference 1, p. 63.