Integrating the Teaching of Science and Social Studies

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This paper calls for the integration of science and social studies curricula in elementary and secondary schools. An expected response to this call would be a charge of fadism or "here we go again." Teachers at all levels, beseiged with frequent requests to do more and do it well with fewer resources, are justified in approaching suggestions for curricular change with reason and caution. These increasing demands on teachers must not prevent us, however, from intelligent reflective thought concerning important curricular linkages for the future. The integration of science and social studies teaching, we believe, is one such promising direction.

The *Ann Arbor News* of February 22, 1981, carried a feature article headlined, "Neutrons Probe Ancient Cultures, Modern Murders." [1] The article detailed the work of a University of Michigan professor of chemistry who had applied neutron activation to probe problems normally left to researchers in the humanities. His research on artifacts had even brought into question long standing economic theories of inflation. That same issue of the newspaper carried stories on French researchers predicting heart attacks by use of a simple blood test, and on researchers in Kansas who are trying to create a radioactive hybrid antibody that would zero in on cancer like a "smart bomb" and destroy malignancies with minimal damage to healthy tissues.

Stories such as these are seen and heard everyday in print and nonprint media. Science and its application through technology has indeed done wonderous things to increase the predictability and quality of life and to help unravel the mysteries of the past. The image of science and technology portrayed in these stories is, of course, the "good guy" image which has been so much a part of our past. We have come to expect science to do just such marvelous things since, after all, "scientists say" and "scientists know."

But this is only one way in which science is portrayed to us today through the inundation of mass media. The good guy image of science and technology is frequently, and increasingly, matched with a Darth Vadar image of science as dark and sinister. After all, science and technology pollutes our air and water, destroys our silence, invades our privacy, puts cancer causing chemicals in our food, and destroys our image of a serene rural past. Will the real science and technology please stand up?

When science was small and relatively simple and when abundance was the name of the game, it was easy for society at large to pay homage to science and to scientists who were constantly discovering new ways to make life better. Certainly there were some concerns how society was changing as a result of new science and new technology, but the benefits seemed to far outweigh the potential consequences.

But science is no longer simple and small, and technology seems to dominate us. The cost-benefit ratio of the past is no longer clear cut. Although we still value science and technology, and few people are willing to return to the past, science and technology is such a dominant aspect of American society that it impacts everything we do from the nature of our sex life, to how we brush our teeth, to fundamental questions of human life. Science and technology have progressed to the point that value dilemmas must be faced today which simply did not exist ten years ago. A decade ago many of our sick and elderly died; now we keep them alive. Ten years ago, premature and deformed babies died; now we keep them alive, sometimes against the wishes of their parents. Ten years ago, one hardly thought it possible to create artificial life; now it is a reality.

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These examples of the interface of science and society suggest several persuasive reasons for integrating science and social studies curricula in elementary and secondary schools. First, at both a personal and societal level, developments in science and technology have caused us to search for new values, values which frequently clash with those long standing from the past. There are many recent examples. At one time in our society we valued large families, and the primary function of marriage and sexual intercourse was to have babies. Now with the pressure of overpopulation and a highly industrialized society and with the developments of effective birth control techniques, what was once done primarily for procreation is now done for recreation. Yet recreational sex, made more feasible through advances in science and technology, has raised serious moral, religious, and ethical questions and has brought new values into direct confrontation with some old values.

Even the development of the super-sonic transport has created a value dilemma. Although most of us still value quickness and efficiency in transportation, an increasing awareness of the limited capacity of our globe to absorb the noise and pollution of modern air transport brings out the value dilemma. Do we want speedy transportation or a clean and serene environment? Can we have both? Now that we have the capacity to build an SST, the public question is if we should do it.

DNA research is yet another example of science and technology forcing us to consider both old and new values. At the same time that we marvel at the wonders of recombinant DNA research, we ponder its meaning and question the nature of creation itself.

These tremendous social impacts of science and technology on our personal and collective values brings us to another important justification for integrating science and social studies, the crucial responsibility of citizen action in social policy decisions involving science and technology. As we have become more aware of both the blessings and limitations of science, key questions are raised as to who should assume responsibility for placing proper controls on emerging technologies. In a 1977 article in *Change* magazine, Wm. J. McGill, President of Columbia University, argued that control of science should be in the hands of the scientists through prestigious commissions, so that decisions are made on expert knowledge and not as a result of over zealous public advocacy.[2] It seems to us however, that Mr. McGill argued the wrong question, for there seems little doubt that decisions concerning the use of science and technology will be made in the public arena. Their impact on the general public is too great to expect less in a democracy. The key issue, then, is not to avoid the public as a component in decision making, but instead how to make those public decisions the very best that we can to insure that progress and justice proceed simultaneously. We must decide as educators how best to provide the public with the knowledge, skills, and attitudes which will make them informed decision makers.

But this leads to another question, if we integrate, can we still teach good science and good social science? Our answer is *yes*, and, indeed, another justification for integration. Not only can we continue to teach good science and good social science, but we can do so within a framework which focuses on topic areas important in the present and future lives of our students while at the same time providing them with the skills and attitudes necessary for informed decision making. A focus on topic areas important in the present and future lives of our students also has the advantage of placing learning in a meaningful context. Although the cry for relevance is frequently overworked, we can not ignore the importance of contemporary topics which students associate with their current life space.

We have been impressed by the fact that in many respects both science and social science deal with the same general ideas (see Figure 1).

FIGURE 1 [3]
SCIENCE AND SOCIETY

TOPICS FOR INVESTIGATION

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Concepts of Science
1. Observation
2. Interaction
3. Relationship among variables
4. System
5. Laws (formal and informal)

Concepts of Social Science
1. Observation
2. Interaction
3. Relationships (social)
4. System
5. Rules (legal sanctions)

↘ ↙

Common Skill Building
1. Defining the problem
2. Developing a tentative answer (hypothesizing)
3. Testing the tentative answer against data
4. Developing a conclusion
5. Applying the conclusion
6. Evaluation

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Considering Social Consequences
1. So what?
2. What if?
3. Values in conflict

Some of these general ideas or concepts we deal with are interaction, the relationship of variables, the nature of system, and formal and informal rules. But the sciences and social sciences also share a common mode of problem solving from problem identification to problem solution, and in both there is a strong emphasis on skills: skills of classification, inference, control of variables, and many others. When knowledge and skills are connected to a consideration of the social consequences of science and technology, and to the key value questions so prevalent in our modern world, the teacher can play a powerful role in helping our citizens of the future understand the complex nature of science in society.

The importance of an integrated focus is reflected in the recent *National Assessment of Science Objectives, Third Assessment*. In the general framework for objectives in the cognitive domain, *Science and Society* is given equal importance with *Science Content* and *Science Process*. Further, when the advisory group made judgments about the relative importance of student outcomes in various categories of *Content*, *Process*, and *Science and Society*, 20% of the involved elements directly related to the *Science and Society* category with an additional 40% clearly related to the integration of science and society—integrated topics, process/methods, and decision making (see Figure 2).

According to Paul Hurd, in the 1978 report to the National Science Foundation on *Early Adolescence*, the curriculum of the future will be societal rather than discipline based. That is, the subject matter will be interdisciplinary, selected for its general usefulness to students and their lives in society, rather than displaying the strict, isolated quality of the disciplines, one by one. Process skills will be formed as much for group and individual decision making as for fostering inquiry. Values issues in science will be considered, and curriculum resources will extend beyond the classroom to museums, industries, school camps, and the out-of-doors.[4]

FIGURE 2 [(5)]
COGNITIVE OBJECTIVES MATRIX

		Knowledge	Comprehension	Application	Synthesis	Percent Weighting
CONTENT	Biology					15
	Physical Science					15
	Earth science					10
	Integrated topics					10
PROCESSES	Process/methods					18
	Decision making					12
SCIENCE AND SOCIETY	Societal problems					7
	Science and self					7
	Applied science					6
Percent Weighting		20%	20%	40%	20%	100%
						TOTAL

For purposes of clarifying the theory portion of this paper with practice, four exemplars of curricular models plus one curriculum development model have been selected for primary emphasis. These are (1) *People and Technology* (PAT), (2) *Human Sciences Program* (HSP), (3) NSTA, *Project on Energy Enriched Curriculum* (PEEC), (4) *Man/Curriculum*, and (5) *Federation for Unified Science Education* (FUSE—a curriculum development model).

One curricular program which we think is especially meritorious is *People and Technology* (PAT), developed by the School and Society Division of Education Development Center. PAT is a multi-media course for junior high students that examines the relationship between technology and human behavior. Through case studies, construction exercises, and community investigations, students study the whaling industry on 19th century Nantucket Island and the building and social impact of the construction of the Volta Dam in Ghana. Inquiry is guided by five organizing questions: (1) What is technology? (2) How do people help shape its use? (3) How does technology affect society? (4) How does technology affect the natural environment? and (5) How can we use technology to create a more humane way of life?[6]

The underlying assumptions in the course about the nature of technology and society and about the nature of the adolescent learner are especially interesting in that they typify some of the potentials which exist in a course which integrates content of the sciences and social sciences. These assumptions are:

1. Technology comes of people; it is part of our humanity. Within limits, we can control technology, for we are its creators.
2. Technological and social systems are closely interwoven; each affects the other. One problem today is to bring these two systems into some adjustment with each other. In working out this adjustment between systems, we must consider and be responsive to human and environmental needs.
3. People view technology differently, depending on their own needs and values.
4. The present and potential impact of modern technology is so great that decisions about its use must be made responsibly. There are no simple solutions. Every decision carries costs and benefits.
5. Before we can make choices about the use of technology, we must understand what it is, and realize that social, economic, and political forces determines its use. These forces are controlled by people and reflect our values.
6. As citizens in a democratic society, we have a responsibility to become informed about technological issues, clarify our values, and, after careful analysis, involve ourselves in the process of influencing decisions that affect the quality of life and the environment.

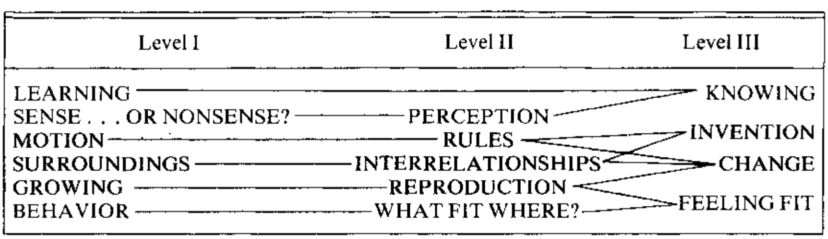
7. It is possible to change society, but doing so is difficult. Change can be achieved through knowledge, understanding, and thoughtful actions. As individuals and members of groups, people can come to use technology in increasingly humane, positive ways.

Assumptions about the nature of the adolescent learner which guided the development of PAT include that they (1) are moving from concrete to abstract thought, (2) are active and energetic, (3) are awkward in social situations, (4) are enthusiastic and full of spirit, and (5) are developing a values system.[7]

The curriculum developers at EDS are to be congratulated for developing a course of study around these particular assumptions. Unfortunately, no commercial publisher has published PAT and it is no longer available from EDC.

The *Human Sciences Program* was developed by the Biological Sciences Curriculum Study in Boulder, Colorado. BSCS developed this program after making an intensive study of the early adolescent so that the curriculum materials would have wide appeal for the 10- to 14-year-old student. The curriculum developers included concept and processes from history, anthropology, sociology, psychology and science and integrated them into fifteen modules organized into three learning levels (see figure 3).

FIGURE 3 [8]



The concepts, principles, and modes of inquiry included in HSP come from life, physical, earth, and behavioral sciences, thus providing a multidisciplinary perspective to the program. Life sciences include content drawn from biology and human biology, with emphasis on behavior and ecological relationships. Chemistry and physics are included under the physical sciences. Earth science includes astronomy, geology, and meteorology. Anthropology, psychology, and sociology reflect the behavioral science emphasis. Science process skills, communication and coding skills, and personal skills complement the interdisciplinary aspects of the program.

The HSP is developmentally based in that it provides experiences that assist students as they pass through the often difficult transition period between childhood and adolescence.

Fifteen modules have been developed, each one designed to provide materials for 200 students and seven to ten weeks' instruction.[9]

Through its *Project for an Energy-Enriched Curriculum*,[10] sponsored by the U.S. Department of Energy, the National Science Teachers Association has produced a series of 34 energy instructional packets for elementary and secondary schools. Written by social studies and science teachers, these materials are designed for convenient infusion into the existing curriculum. They feature a wide range of activities which encourage direct student participation while introducing basic energy concepts.

The Upper St. Clair School District, Upper St. Clair, Pennsylvania (1980), has been experimenting with integration of science and social studies in grades 6 through 8 over a period of several years.[11] The district describes the curriculum as the integration of cultural studies and science. Students progress through the program by means of group pacing through separate content, continuous progress through interest content, and individual pacing through integrated content. Examples of integrated units are:

Cultural Studies-Science Integration

Basic Themes:

1. Man as a Biological Organism
2. Man in Relation to His Total Environment

Topics for Phase III Integration:

Level One

1. The Interaction of Man and Environment
2. Food and Agriculture
3. Land, Climate and Vegetation
4. Water, Air and Weather

Level Two

1. The Earth's Natural Resources
2. Science and Technology: Impact on Man
3. Population: One Earth, Many People
4. Science and Conflict

Level Three

1. Transportation and Communication
2. Science and Man's Health
3. Environmental Problems
4. Urban Planning for the Future

Level Four
1. Natural Resources, Machines and Change
2. Man and His Global Environment
3. Energy: Challenge to Man
4. Science and Decision-Making in a Democracy

Course objectives for the Phase III integration are not available, but the topics listed should provide the reader with an understanding of the areas of knowledge that can be integrated.

Establishment of the Center for Unified Science Education was made possible by a grant from the National Science Foundation to FUSE and by additional support from The Ohio State University and ERIC for Science, Mathematics, and Environmental Education. It is presently located at Capital University in Columbus, Ohio.[12]

The Center has been established to disseminate the concept of unified science education and to facilitate the implementation of high quality unified science programs. These purposes correspond to the originating purposes of the Federation for Unified Science Education.

In working with schools considering implementation of a unified science program, personnel from the Center for Unified Science Education have been recommending a nine-phase approach:

1. Assemble a working group of teachers who have concerns and responsibilities for the science program. The group should represent K-12 or as broad a grade range as possible.
2. Explore, as a group, the concept of unified science education and the diverse specific programs that it has fostered.
3. Review and, if appropriate, revise the objectives and purposes for the total science program. Consider the local implications of the statement on objectives by National Assessment, 1979.
4. Assess the current program in terms of present objectives and purposes. Use quantitative data if possible, qualitative if necessary, but do not get bogged down in lengthy data acquisition projects.
5. Assemble a group of outside consultants. The group should include college people from the sciences and education, people who have had experience in developing unified science programs, and local people who will be concerned about changes in the science curriculum.
6. Establish guidelines for the unified science program, a schedule for producing the program, and identification of necessary financial resources. Plan to implement only one grade level per year.
7. Design the program using modular units as the basic components. Include at least one science/society issue in each unit. Evaluation in terms of the guidelines established in Phase 6 should be considered an integral part of the program. People who will actually teach the program must be involved in this phase.
8. Produce the program materials.
9. Field test the program.

These nine phases should be regarded as tentative and changes should be expected in actual use.

The Center for Unified Science Education has established resources intended to be of use to working groups in schools in each of the recommended nine phases described previously.

These resources include detailed unified science program descriptions at all grade levels, an extensive collection of student materials from unified science programs, exemplary modular units, and evaluative studies and instruments related to unified science programs.

CONCLUSIONS

1. There is ample evidence from the literature, curriculum studies and research on how children learn, that the integration of science and social sciences curricula is feasible and should play a more dominant role in curriculum development. The National Assessment objectives are powerful descriptors of change in objectives to accomplish scientific literacy.
2. Science and social science deal with many similar ideas: integrative concepts, processes, and problem solving models. When knowledge and skills are connected to the social consequences of science and technology a powerful decision making tool is available for use by citizens. The end result should provide citizens the power to make social policy decisions related to science and technology.
3. Integration of science and social sciences assists students in finding meaning in these subjects in relation to the kind of world in which they will spend *their* lives. Recent National Assessment data indicated that about 37% of the 9-, 13-, and 17-year-olds felt that things they learned in science would be more useful in the future than to their present everyday life.[13] Students have been taught the basic constructs of science and its investigative procedures, but nothing follows. There is no mention in the curriculum of transactions between science and society, nor the intellectual and aesthetic benefits of science. Average citizens seek relevance and significance for what they are expected to learn and do so in a manner that helps them toward goals they care about. "Good" science and "good" social sciences can be taught within a framework which focuses on problem solving and decision making while placing learning in a meaningful context.

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8. NOTE: Further suggestions about teaching HSP can be obtained through the excellent guide, *Teaching Human Sciences*, published by BSCS; P.O. Box 930; Boulder, Colorado, 80306. Information about the purchase of HSP modules can be obtained from C&F Associates; P.O. Box 41; 908 W. Wilson St.; Batavia, Illinois 60510.
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10. NSTA *Project for an Energy Enriched Curriculum* materials were formerly available free of charge from the Department of Energy. Alternate funding is being sought to continue distribution.
11. NOTE: Further information can be obtained from either James Smoyer or William Tomey, Upper St. Clair Schools, Upper St. Clair, Pennsylvania 15241.
12. NOTE: Further information can be obtained about FUSE from Dr. Victor Showalter; FUSE Center; Capital University; Columbus, OH 43209.
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