FURTHERING BETTER COMMUNICATION AND UNDERSTANDING OF NUCLEAR ISSUES THROUGH PUBLIC EDUCATION: A PUBLIC SCHOOL TEACHER'S PERSPECTIVE

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ABSTRACT

Recent reports of national commissions and study groups have pointed out that the American educational system is not meeting the needs of its students. Uniformly, the reports call for a new instructional focus designed to achieve the goal of "universal scientific and technological literacy for citzenship." The population's inability to deal with numerous controversial science-related social issues forms the basis for this call for educational reform. Foremost on the list of science-related social issues are nuclear issues in general and the storage of nuclear waste in particular.

The National Council for the Social Studies (NCSS) 1983 publication "Guidelines for Teaching Science-Related Social Issues" was designed to encourage stronger instructional emphasis on science-related social issues, and to provide social studies teachers with a rational and structure for the presentation of the issues.

This paper discusses the dilemmas faced by educators who attempt to deal with science-related social issues. Also, it addresses the need for instructional materials in order to effectively address nuclear issues in the classroom.

INTRODUCTION

One of the most perplexing instructional problems faced by educators in recent years revolves around classroom teachers' abilities to meet student requests for information and discussion about nuclear issues. The classroom teachers' search for usable information about nuclear issues is more urgent and more frustrating than the scientific community, commissioned study groups, the public, and the commercial publishers of school materials realize. If handy references, or rational, valid, reliable sets of instructional materials about nuclear issues exist, they are not in evidence in school or classroom teacher's libraries. After a search of the school library, the state adopted textbook list, and numerous publishers catalogs, the classroom teacher feels like "Old Mother Hubbard". When the teacher got there, the cupboard was bare - and the educator was faced with a situation requiring a choice between sets of equally undesirable alternatives.

> Do we sit by and watch our students starve because scientists who can contribute to a balanced intellectual diet are unaware of and inattentive to the needs of educators?
>
> Do we jump on the bandwagon of dietary programs espoused by organized groups who are operating in the name of social responsibility?

Intellectual nourishment sustains and promotes intellectual development. Deficiencies in diet of the young often produce irreversible maladies in the adult. In this day and age it has become common practice for hospitals to advertise to promote their images and services in the name of consumer education. It seems appropriate that scientists who are specialists in the nuclear field take up the educational challenge. In doing so, not only would the intellectual diet of our nation's students become more balanced, but also the public image, integrity, and intellectual position of nuclear scientists would improve.

BACKGROUND

In the fall of 1983, the media began reporting the results of a number of recent studies which focused on the status of American education. Newspapers, magazines and television brought the findings and recommendations of the status studies before the American public. The primary message of the reports was that the public schools of our nation are in trouble. In August of 1983 the National Association of Secondary School Principals published an Almanac of National Reports [1]. The Almanac, a summary of seven major task force and commission studies, synthesized educational problems and recommendations for reform identified by the studies. Collectively, the studies appeared to be sounding the warning to the literate segment of American society that our survival as a nation in the international community is dependent on the improvement of our educational system. The studies and reports stated that efforts directed toward the improvement of education must include a commitment from all segments of society including professional societies and industrial organizations who, here-to-fore, have remained passive toward public education, or who have participated in a self-serving manner. The reports call for a refocus of educational objectives, goals and priorities and issue an imperative call for the development of scientific literacy for citizenship.

In general, the national commissions and study groups have based their calls for reform on the need for a more energetic attitude on the part of educators. Essentially, the reports characterize the American educational system as a producer of inferior and defective products who are unable to contribute to the success of the nation, the national defense, the social stability, well-being and national prosperity of the country. They refer to national economic challenges and compare the Japanese infiltration of the American marketplace to a modern version of the 1957 Sputnik challenge. Each report emphasizes the seriousness of declining literacy and lack of student interest and

skill in mathematics and science. "Excellence in education," and "scientific literacy for citizenship" are rapidly becoming new slogans and key phrases of the 80's reform movement. Often quoted dismal statistics include:

- Some 23 million American adults are functionally illiterate by the simplest tests of everyday reading, writing and comprehension.
- Many 17-year-olds do not possess the "higher order" intellectual skills we should expect from them. Nearly 40 percent cannot draw inferences from written material; only one-fifth can write a persuasive essay; and only one-third can solve a mathematics problem requiring several steps.
- There was a steady decline in science achievement scores of U.S. 17-year-olds as measured by national assessments of science in 1969, 1973, and 1977 [2].

THE PROBLEM

While calls for reform represent the first step in the lengthy process of producing change, the actual production of change requires more than a recommendation or a demand. Finkel [3] stated, "Everywhere, people are demanding higher standards and better results. If this were the situation in other professions, we would probably see increased emphasis on research and development." He pointed out that education is different from other professions in that educators have little faith in educational research and seldom are they persuaded to act on the basis of research alone. Further, Finkel noted that researchers and practitioners tend to live in separate worlds, with limited "interplanetary" communication.

The call for "scientific literacy for citizenship" has renewed and heightened awareness of the necessity and importance of communication not only between educational researchers and practitioners, but also, and more importantly, between members of the scientific community and educators in general. Educators who are grappling with this new challenge recognize that there are no simple, clean-cut solutions to the problem. Leaders in the fields of social studies and science education have been communicating. They have begun to consider the impact that this recommendation will have on the curriculum. They have noted that the studies refer to universal scientific and technological literacy, and that all students, not just the gifted and talented be required to receive instruction. Some of the questions to which there are no answers at the present time include:

1. What exactly does the phrase "scientific literacy for citizenship mean, and what criteria will be used to determine whether scientific literacy has been achieved?
2. Since the phrase includes both science and citizenship, does the task of producing scientifically literate citizens fall into the domain of social studies or science education?
3. Are teachers in either field - social studies and/or science - trained to cope with the types of scientific information, skills and instructional strategies that will be required to produce scientifically literate citizens?
4. What should be thrown out of the present overcrowded curriculum in order to make space and time for the new intellectual challenges?
5. Should educators develop new and separate programs for the social studies and science content fields, or should they join forces and produce an interdisciplinary program which focuses on Science and Citizenship?
6. Whether new programs are created, or old courses are revamped, where and how do educators gain access to the scientific knowledge required to respond to science issues?
7. Which of the numerous science-related social issues are most provocative and require immediate attention in the curriculum?
8. In terms of the conceptual and development stages of the learners, what grade level in the K-12 curriculum is the most appropriate for the introduction and the study of science related social issues?
9. What is the most appropriate format for materials that deal with science-related social issues? Sets of mini-units? Case Studies? A single textbook?
10. Who will provide the financial support required to plan, develop, test and produce programs and materials which focus on the production of a scientifically literate citizenry?

Today, the most controversial of all science-related social issues appears to be nuclear issues. Although the recent educational reports do not rank nuclear issues as the most pressing of public concerns, the reports refer to nuclear issues and use them as examples of an area in which increased scientific literacy is essential.

It seems that the mere mention of the word "nuclear" tends to evoke negative opinions and reactions from children and adults alike. Whether the word is used as a modifier for power, weapons, waste, medicine, or war, the reaction is generally negative. Classroom discussions about nuclear issues often focus on nuclear weapons or the possibility of nuclear war. When discussions occur, they frequently begin as impromptu affairs with questions raised by students. Discussions tend to be little more than opportunities to express unfounded opinions. Most often, discussions end in the same place they began - with questions that need to be answered. Classroom teachers who are interested in furthering the intellectual development of their students in a rational and organized manner encounter difficulty when dealing with this science-related social issue. The problem is one of lack of personal information as well as lack of appropriate materials for students.

SEARCHING FOR ANSWERS AND INSIGHTS ABOUT THE CAUSES FOR A CALL FOR CURRICULUM CHANGE

Traditionally, the accepted work of our nation's schools has been the production of a literate citizenry. The term literacy refers to the ability to read and write. It carries with it the idea that a literate person is one who possesses, displays, and uses knowledge in problem-solving and in decision-making situations. Today, schools across the nation are being scrutinized because statistics indicate that the production of literacy has dwindled. Solutions to the problem of dwindling literacy, a serious matter in its own right, have been complicated by recent calls for a strong instructional focus on "scientific literacy for citizenship."

In 1975, Tanner and Tanner [4] discussed their

ideas about the causes that bring about educational reform movements. They indicated that curriculum reforms have tended to be undertaken as a response to societal crisis and that innovations and reforms tend to be short-lived. They explained that as each era of societal crisis appears, a call is made for yet another turn about in the direction of educational change. As each call for change is made, there is generally little agreement as to whether the dominant source and influence for curriculum development is coming from organized scholarship and the work of scientists and experts, or a recognition of the needs of the learner, or the recognized and expressed needs of adult society.

The Tanners' perspective sheds light on some of the reasons for the present day call for educational reform. Scientists who are being approached for assistance in the 80's need to consider the following analysis.

It appears that the adult segment of our present day population passed through the American educational system during the time when learners were segregated according to ability. Gifted and talented students were classified as prospective scientists and were prepared for advanced study of science and mathematics. While these students were privy to scientific information, methods of scientific research and problem solving, the majority of their peers were assigned to "regular" classes. During the period of ferment which followed Sputnik, scientists and educators occupied dominant positions in education while the elite group of learners scrambled to become today's research scientists and engineers.

Some twenty-six years after Sputnik the focus of education is being directed toward all learners - not just the gifted and talented. The goal of education is nothing less than scientific and technological literacy for citizenship. Today, educators are finding themselves in solicitor's roles as they begin to open avenues of communication and seek assistance from scientists who, for the past two decades, have occupied, for the most part, a passive position in educational matters. It is no wonder that a recent Association for Supervision and Curriculum Development (ASCD) newsletter bannered the headlines "Schools Scramble to Adapt Science Curriculum" [5].

In large measure, the scramble to adapt curriculum is a response to the recent national reports. A Nation At Risk, [2] one of the first published studies of the 80's reform movement, amply documented the dimensions of America's educational problems. In this report, The National Commission on the Excellence of Education, called for immediate change and referred to "chilling observations" made by analysts who examined student performance in skill development and achievement "within the context of the modern scientific revolution." The report stated that we are raising a new generation of Americans who are scientifically and technologically illiterate. They warned of "a growing chasm between a small scientific and technological elite and a citizenry ill-informed, indeed uninformed, on issues with a science component."

SCIENTIFIC LITERACY FOR CITIZENSHIP A DEFINITION - GOALS AND ISSUES

Definition

Authors who have written about scientific literacy for citizenship tend to avoid making succinct statements about the meaning of the concept. Rather, they devote attention to describing the characteristics of a scientifically literate person and they list examples of science-related social issues that a citizen should be able to make decisions about.

Prewitt [6] speaking in favor of the scientific literacy movement described its meaning from a democratic perspective. He stated: "From the perspective of democratic practice, the notion of scientific literacy does not start with science itself. Rather it starts at a point of interaction between science and society." He believes that it encompasses an understanding of the nonscientific purposes of science and explained that it is on these matters that citizens are frequently asked to vote. Prewitt described a scientifically literate person as one who understands how science and technology impinge on public life.

According to Hurd [7] "Scientifically and technologically literate citizens recognize the need for and are capable of making ethical judgments regarding science/technological problems and issues." Hurd believes that people should be capable of distinguishing questions of science from those of technology and that they should be able to recognize the limitations of each field for dealing with a problem. Scientifically literate citizens are those persons who are capable of making decisions for action that will influence human well-being, the national welfare, and the quality of life.

While Murray [8] does not specifically refer to scientific literacy for citizenship, his opening remarks suggest that his efforts were focused in that direction. Like Prewitt and Hurd, [6,7] Murray expressed the belief that an informed public will make the best decisions about nuclear issues. He pointed out that the ability to distinguish knowledge (fact) from opinion in an unbiased and candid manner will go far in cutting down on public confusion caused by conflicting statements about nuclear energy and the waste problem.

Goals

Goals of the scientific literacy movement appear to be directed toward the production of a citizenry literate in 1) methods of gathering information on science-related social issues; 2) displaying a measure of expertise in sorting out the technological, economic, and political segments of issues; 3) exhibiting ability to make informed choices. Overall, expectations are held that students will understand the positions that science and technology occupy in directing their social and personal lives [1].

Issues

The notion of scientific literacy for citizenship appears to be floating on a sea of science-related social issues. Nuclear issues are mentioned prominently. Prewitt [6] commented that issues on the American political agenda, such as radioactive waste management and arms reduction have technical dimensions which are beyond the comprehension of practically all citizens. Hurd [7] identified science-related social issues as those which include air, water and soil pollution; environmental management; energy resources; health and nutrition; nuclear power; overpopulation; genetic engineering; human organ transplants; life sustaining support systems; and safety.

Shamos [9] on the other hand, espouses the view that technological literacy takes precedence over scientific literacy. His list of issues to be confronted included nuclear power, environmental pollution, genetic engineering and robotics.

TO WHOM DOES THE TASK OF PRODUCING SCIENTIFICALLY LITERATE CITIZENS BELONG?

Social Studies

The National Council for the Social Studies (NCSS) has been a staunch advocate of the idea that citizen participation in public life is essential to the health of our democratic system" [10]. To that end, NCSS members have devoted much effort and time to the production of a series of documents which serve as guidelines for educators and curriculum developers.

Early in 1983, NCSS published "Guidelines for Teaching Science-Related Social Issues" [11]. This document presents suggestions for choosing topics for classroom discussion, evaluating existing materials, setting objectives in areas of gathering, processing, evaluations and applying information to science-related problems and social issues, and for evaluating student achievement of these objectives. The Guidelines represent the NCSS position that there is a need for an integrated, interdisciplinary approach in the presention of science-related social issues. It states: "Certain basic understandings are best learned when content areas are brought together in studying critical issues... The integration of content areas must be preceded by an awareness that the integrity of each discipline is regarded."

In 1979, NCSS published a revision of the NCSS Curriculum Guidelines [12]. This document outlines standards and objectives for exemplary social studies programs. The following statements are included:

- o The program should demonstrate the relationships between the local and global aspects of social issues.
- o The program should include analysis and attempts to formulate potential resolutions of present and controversial global problems such as racism, sexism, world resources, nuclear proliferation, and ecological imbalance.
- o The program should draw from other related fields such as law, the humanities, the natural and applied science, and religion.

The Essentials Statements [10] published in 1980 are a response to the "Back to the Basics" movement. This document was endorsed by nineteen professional organizations including the National Science Teachers Association and the National Council for the Teachers of mathematics.

In addition to strengthening reading and computation, there is a wide variety of thinking skills essential to social studies which can be grouped into four major categories: Data Gathering Skills, Intellectual Skills, Decision Making Skills and Interpersonal Skills. As a civic participant, the indivividual uses the knowledge, beliefs and skills learned in school, the social studies classroom, the community and the family as the basis for action.

Traditionally, the teaching of social/public issues and citizenship has been a recognized and accepted part of social studies instruction. One need not look far into the textbooks and materials of the social studies before it becomes apparent that the study of history, geography, political science, economics and the other social sciences which form the foundation of this subject area involve the study of numerous science-related social/public issues. In 1975, Tilford [13] in her Foreword to the NCSS 45th Yearbook Stated: The social studies teacher bears great responsibility for seeing that the student has a right to hear, to read, to discuss and to reach judgments about a great variety of societal issues." Tilford went on to quote from the NCSS Statement on Academic Freedom which proclaims:

> It is the prime responsibility of the schools to help students assume the responsibilities of democratic citizenship. To do this, education must impart the skills needed for intelligent study and orderly resolution of the problems inherent in a democratic society. Students need to study issues upon which there is disagreement and to practice analyzing problems, gathering and organizing facts, discriminating between facts and opinions, discussing differing viewpoints, and drawing tentative conclusions. It is the clear obligation of schools to promote full and free contemplation of controversial issues and to foster appreciation of the role of controversy as an instrument of progress in a democracy.

The study of social issues is an integral part of social studies education. Generally, social issues are examined in depth. The examination includes reading and research, and planned, structured classroom discussions. Factual information, opinions and opposing views are gathered, analyzed and evaluated. Critical thinking, problem-solving and decision-making skills are employed. Teaching and learning activities as well as competencies to be achieved are identified and stated as objectives. These objectives then become the basis for evaluation of student performance and competence. When this type of learning activity takes place, the teacher occupies the positions of director of learning and facilitator of instruction. In the director of learning role, the teacher's responsibilities include instruction in the skills required to achieve competence. As a facilitator, the teacher acts as an overseer of skill performance and discussion. One of the goals of this type of classroom activity is the production of competencies in citizenship.

Remy's work [14] in the area of citizenship competencies is notable. He defined and charted seven basic citizenship competencies. His charts identify capacities which contribute to each level of competency, and he provides a listing of skills and attitudes related to each level of competency. Remy's seven basic competencies include:

1. Acquiring and Using Information.
2. Assessing Involvement.
3. Making Decisions.
4. Making Judgments.
5. Communicating.
6. Cooperating.
7. Promoting Interests.

The foregoing discussion has made the point that social studies teachers have at their fingertips a variety of published models and materials which define the intellectual components required to produce competency in citizenship. Yet, a serious problem exists. The problem has to do with the nature and content of the social issues of the 80's, and the absence of materials which form the knowledge base from which to operate. Teachers feel defeated before they begin

because they cannot even take the first step. The first step in the process of dealing with social issues is the acquisition of information.

The lack of information on science-related social issues appears to be a universal problem. Information that is available is generally rejected as not usable in the classroom. Reasons why teachers reject what little information there is available have to do with inappropriate instructional formats, the use of overpowering vocabulary, and the unevenness of reading levels which might range from 9th grade to 17th grade level on the same page. Clearly, a problem exists. If science-related social issues, such as nuclear issues, are to be addressed in the classrooms of this nation, an effort must be made to provide appropriate instructional materials.

Dilemmas facing educators who wish to implement some of the recommendations made in the call for reform do not end here. None of the status studies and reports suggested how educators in any field of instruction were to go about implementing change. How the goals of the present reform movement will be accomplished appears to be a matter left in the hands of educators and various professional organizations who support or represent particular content fields. It should be noted that while the social studies appeared to receive light attention in the national reports, the curricular areas of mathematics and science received heavy focus and attention.

Science Education

Recently, the Association for Supervision and Curriculum Development devoted an entire issue of its official journal, Educational Leadership, [15] to the theme "Mathematical and Scientific Literacy for the High Tech Society." Contributors to this issue included a number of nationally prominent science educators. They discussed new approaches for the teaching of science and appeared to be in agreement that students need help in understanding the applications of technology to daily living.

Yager [16] reviewed recent assessments of school science and noted:

> The existing science curriculum focuses on the traditional disciplines of biology, chemistry, physics, and earth science, and is controlled by the textbook... Textbooks emphasize content in a discipline context stressing the concepts, and words unique to science. The vocabulary of science at a given grade level is often greater than the vocabulary students must learn when taking a foreign language. In general, school science... is appropriate only for the few students who aspire to (and even fewer who attain) careers as professional scientists and engineers.

Yager discussed science instruction and perceptions people hold about science teachers:

> Teachers tend to present science via lectures with question-and-answer techniques; few are aware of any instructional strategies other than direct teaching. And most instruction is whole-group, geared to the average student... Generally, science teachers, at the secondary level, are perceived as "knowing" science and as answer-givers.

Paul DeHart Hurd [7] agreed with Yager and went a step further in denouncing the present science curriculum. He stated: "The science curricula that are most widely used in schools are now viewed as too narrow and too discipline-bound to serve individual and national needs in a high-technology society."

Shamos [9] advocated technological rather than scientific literacy for all. He contended that:

> We have not learned how to teach science to the nonscience student in a meaningful yet painless fashion... all efforts to develop broad scientific literacy have failed, including the massive effort that followed Sputnik, and there is no reason to believe that new attempts to achieve widespread public literacy will be any more successful.

The statements of Yager, Hurd and Shamos appear to be truthful descriptions of the present status of science education. Curriculum reform in science education appears necessary. But who will take the lead in designing new programs? Yager,[16] a past president of the National Science Teachers Association, remarked, "Resolving the current crisis in science education will mean focusing on goals other than academic preparation." He went on to quote a recent position statement issued by the National Science Teachers Association which proclaimed that the primary focus of school science for the 1980's should be on the relationship between science and society.

There appear to be no easy answers to the question, "To Whom Does The Task Of Producing Scientifically Literate Citizens Belong?" Science education does not appear to be in any condition to handle greater requirements at the present time. Social studies education, on the other hand, seems to be better prepared to deal with citizenship competencies. The literature of the field is rich in models and information on intellectual skills related to critical thinking, problem-solving, and decision-making. The most serious problem confronting both science and social studies education at the present time is the absence of information and appropriate instructional materials that deal with pressing science-related social issues such as nuclear issues.

CONCLUSIONS

Long before the results of studies by the National Commission on Excellence in Education and those of other groups were made public, educators were cognizant of the fact that students and adults alike were seeking information on such topics as pollution, radioactive waste disposal,and nuclear issues in general. In response to social studies teachers' requests for suggestions about how to deal with these science matters in social studies classes, the Science and Society Committee of the National Council for the Social Studies formulated a set of Guidelines for Teaching Science-Related Social Issues [11].

Now that the Guidelines are available, the next problem to be grappled with is the absence of usable information about science-related social issues. The lack of comprehensible information has become more critical in light of the recent call for "scientific literacy for citizenship". Educators are aware of the complex nature of the information they are seeking. Neither social studies nor science teachers have had comprehensive training in the scientific matters that have become public issues, and this awareness is causing uneasiness and stress. Hence, it seems logical to request assistance and information from the experts who deal with the information on a daily basis.

What is needed is a bridge to link the gap between the work of scientists in their laboratories and the work of educators in their classrooms. Communication has never been more essential than it is now. Human beings have a tendency to fear what they do not understand, and there is certainly little information available to aid in the first steps to understanding. Hosford [17] discussed the resistance that bridge builders encounter when they try to bring new knowledge into common practice. His observations are worth repeating here. He stated:

> Between the discovery of knowledge and its successful application lies a swampland of fears. Historically, these fears are rooted in religion, self-defense, ignorance, and assorted emotional needs. Fearful resistance to translating new knowledge into practice is not unique to the field of education. Socrates, Ptolemy, and Gallileo all suffered at the hands of those who feared the meaning and possible consequences of the new knowledge they proclaimed.

Whether teaching about science-related social issues becomes a part of the domain of science or social studies, or whether a new interdisciplinary program is created, the need for intellectually sound, unbiased information will remain. The sooner construction work begins on the bridge, the better.

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