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TWO MODELS FOR THE TEACHING OF SCIENCE-RELATED SOCIAL ISSUES

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In the past ten years, major reports have appeared criticizing the educational system. A number of these suggest that schools are not producing adults willing to take an active citizenship role in society. Such reports as *A Nation at Risk* (NCEE, 1983) and *The Carnegie Report* (Boyer, 1983) are among many general education studies which address this point. Reports from specific content areas (Harms & Yager, 1981; Patrick & Remy, 1985; Ramsey & Hungerford, 1988) have also voiced concern regarding a seeming lack of American interest in dealing with the many science, technology and society (STS) issues which face the nation today.

Guidelines have been produced in the areas of science education (Harms & Yager, 1981), environmental education (UNESCO, 1978) and social science education (Science and Society Committee, 1983) expressing a need for instruction to develop students aware of issues, able to analyze issues and, finally, able to take appropriate action aimed at their solution. Several recent surveys of practicing teachers (Bybee & Bonnstetter, 1987; McLaughlin & Simpson, 1988; Rubba, 1986) show that teachers also believe instruction in science-related social issues (SRSI) is important.

In science education, the emphasis on SRSI reflects a focus change from the 1950's. At the time of Sputnik, the main emphasis of science education was to produce more scientists, a goal which addressed only 2-3 percent of science students and produced negative attitudes toward science in many students (Harms & Yager, 1981). Today, however, the National Science Foundation (Puglia, 1988) believes that enough scientists have been produced and this emphasis is no longer needed. A similar conclusion was reached in a respected 1983 national synthesis of several major research studies (*The Status of Pre-College Science, Mathematics and Social Science Education: 1955-75,* Helgeson, et al, 1977; *Case Studies in Science Education,* Stake & Easley, 1978; 1977 *National Survey of Science, Mathematics and Social Studies Education*, Weiss, 1978) that resulted in a document known as Project Synthesis (Harms & Yager, 1981). This study looked closely at current practices in science classrooms and compared those findings to what selected scientists and educators thought should occur for students to become scientifically literate citizens. The study produced the following list of four goal clusters designed to define literacy and serve as a focal point for the development of new curricular programs. The aim

is to make the skills and content of science classes more applicable to society as a whole.

Goal Cluster 1: *Personal Needs.*
Science education should prepare individuals to use science to improve their own lives and to cope with an increasingly technological world.

Goal Cluster 2: *Science-Related Issues.*
Science education should produce informed citizens prepared to deal responsibly with science-related social issues.

Goal Cluster 3: *Academic Preparation.*
Science education should allow students who are likely to pursue science academically as well as professionally to acquire the academic knowledge, skills and attitudes appropriate for their needs.

Goal Cluster 4: *Career Awareness.*
Science education should give all students an awareness of the nature and scope of a wide variety of science- and technology-related careers open to students of varying aptitudes and interests (Harms & Yager, 1981).

The discussion which follows emphasizes curricular materials available to meet Goal Cluster 2 as well as the research conducted in this area.

Goal Cluster 2 focuses on a need to produce citizens able to deal responsibly with science-related social issues. These issues, often labelled STS issues, must meet two criteria: 1) they must be topics about which people disagree, and 2) they must be of social significance relating to science or technology in some manner (Ramsey & Hungerford, 1988). Examples of topics which fit this definition include aspects of abortion, genetic engineering, ground water contamination, endangered species, solid waste management, acid rain and ozone depletion.

SRSI research is still in its infancy, but, in the field of environmental education (EE), a similar emphasis has been stressed for over twenty years (Disinger & Wilson, 1986). Since the broader scope of SRSI includes environmental issues, the EE research emphasis need not be ignored here (Rubba & Wiesenmayer, 1985). In 1980, Hungerford, Peyton and Wilke produced a set of four hierarchical goal statements for curriculum development which hinged on the superordinate goal for EE focusing on the development of environmentally active citizens. According to these goals, four levels of instruction must be addressed to produce citizens willing to take responsible action in regard to an issue. In 1988, Ramsey and Hungerford modified these goals to address STS issues generally.

Goal Level I: *STS Foundations*
This goal level seeks to provide the learners with the knowledge necessary to make sound decisions with respect to STS issues. Generally, this knowledge is associated with the nature of science, technology and society, and their interrelationships. Specifically, this knowledge is associated with those facts and concepts related to discrete STS issues.

Goal Level II: *Awareness of Issues*
This goal level seeks to foster the conceptual awareness of the science-related social issues originating from the interactions of science, technology and society . . . and of the need for the resolution of STS issues through investigation, evaluation, analysis of personal beliefs and values, decision making and citizenship action.

Goal Level III: *Investigation and Evaluation*
This level provides for the development of the knowledge and skills necessary to permit learners to investigate issues and evaluate alternative solutions for resolving these issues. Similarly, values are clarified with respect to these issues and alternative solutions.

Goal Level IV: *Action Skills: Training and Evaluation*
This level seeks to guide the development and application of those skills necessary for learners to make responsible decisions and take positive action aimed at the resolution of STS issues.

This focus on four discrete levels of issue instruction goes beyond what is normally found in curriculum programs according to surveys conducted by Childress (1978) and Volk (1983). Typical programs attain little more than the awareness level (Goal II) as students read about problems and issues in a text and then participate in a discussion concerning those issues. Research clearly shows that instruction at the awareness level is not enough to produce active citizens (Ramsey, 1979).

More can, and should, be done with issues instruction if responsible citizenship is to be a goal. Until recently, only two models existed to aid teachers in the training of students for issue investigation and action. First was the awareness-level case study format which involved instruction on a single STS problem or issue and provided information to explain the status of the issue. This approach accomplished little more than the reading and discussion strategy many teachers used. However, more recent modification deals with all four goal levels (Ramsey & Hungerford, 1988). It is discussed later in this article as the extended case study. The second approach is a skill development approach (Hungerford et al, 1988). This approach trains students in the skills associated with investigation and resolution of issues and then allows each student to autonomously investigate an issue of his/

her own choice. This issues investigation and action approach has been used extensively in schools and has an established research base to substantiate its claim of producing students willing to undertake citizenship behavior (Ramsey, 1979; Ramsey, 1988; Klingler, 1980; Holt, 1988).

This issues approach is currently being used successfully in many Midwestern middle schools largely as a result of special teacher training received through NSF grants. Although this format does work well, not every teacher who wants to teach issues may find it feasible. Potential problems include the amount of time necessary (16-18 weeks) as well as students' access to research materials on various issues. Necessary research materials may not be available in smaller schools, or materials may not exist at a suitable reading level for younger students. This model also requires a change in the role of the teacher, necessitating him/her to step aside and allow each student to determine his/her own focus of investigation. Some teachers find this loss of control threatening. Further, the teacher must have general knowledge concerning a large number of issues in order to aid students with personal investigations. These problems have led to the development of a second strategy which allows group investigation while still addressing all four STS goal levels.

Called the extended case study, this strategy is based on the traditional case study approach, but extends far beyond the level of instruction associated with a case study previously. In this approach, students are first provided with instruction to provide a basic level of knowledge focused on a single locally important issue. For instance, an extended case study on endangered species would begin with an introduction to STS foundation topics (Goal Level I) such as habitat, niche and population dynamics. Next, at Goal Level II, students are made aware of the many issues associated, for example, with species management problems through an analysis of the many players, their positions, beliefs and associated values. The focus at Goal Level III is student involvement in a single, teacher-directed group investigation on some aspect of a specific issue. For example, loss of species habitat for eagle nesting might be used in the endangered species case study. Finally, at Goal IV, students learn issue resolution skills and action strategies to employ in an attempt to help resolve a particular issue. At this level, students may take action as individuals or members of a group (Ramsey and Hungerford, 1988). Characteristics of this extended case study format that make it different from the issue investigation and action approach include 1) the more traditional roles of both students and teachers, 2) the amount of time required for completion of a case study (only 4-6 weeks) and 3) the scope of knowledge required by teachers. Wide issue knowledge is not necessary with this format because all necessary background information is included in a completed case study.

The first extended case studies were developed by teachers at Southern Illinois University at Carbondale (SIU-C) in an NSF funded project in the summer of 1987. Since then, teachers of science in grades 2-12 have completed extended case studies on such issues as endangered species, acid rain, ground water contamination and land use. In other SIU-C workshops, teachers of health, agriculture and home economics have also used the model to construct units on topics such as AIDS, food additives, secondary smoke, teen pregnancy and world hunger.

The extended case study model appears to have exciting potential for issue investigation by elementary teachers and students. However, difficulties do exist. A great deal of time and effort must be invested by teachers as they develop their own curriculum and plans for its use. Research is also lacking to support the claim that the use of case studies will promote changes in citizenship behavior. Only one similarly designed study has been completed: Students in a self-contained fifth and sixth grade classroom completed an issues investigation associated with deforestation (Withrow, 1988). The results were similar to those of Ramsey (1988). A more extensive study is now in progress concerning the effects of a Canada goose management case study (Culen and Simpson, 1988) on the issue-related behavior of Midwestern fifth and sixth grade students.

Both the extended case study and the issue investigation and action modules appear to provide certain benefits. When interviewed, teachers who had participated in skill development and training programs and then used the materials in class commented on the high level of motivation demonstrated by their students. These teachers felt the models were appropriate for students of all ability levels even though they had originally expressed fear that these approaches could only work with "gifted students." Teachers believed student retention of associated subject matter had improved, and several also noted improved social behavior by students after completion of the units. Elementary teachers were especially pleased with the interdisciplinary nature of the materials which allowed the integration of mathematics, social science, language arts and science class.

If, as Project Synthesis suggests, a goal of science education is the production of citizens capable of dealing with science-related social issues, then changes must be made in our existing method of preparing those students. Models such as the two described here must be incorporated into a comprehensive science program reaching across grades and subject areas. An articulated program might well use the extended case study approach with younger students followed by the issue investigation and action training modules for older students. New curriculum materials must be prepared, and inservice training programs focusing on issue-related skill development must become more widespread to prepare teachers to use the materials. Available materials offer a strong beginning, but only if similar efforts continue

can we hope to produce the type of involved student that society appears to want and need.

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