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ABSTRACT

This science/technology/society (STS) training manual is designed to help state-level coordinators, university teacher educators, district coordinators, or lead teachers to implement the guidelines provided in "Science/Technology/Society: A Framework for Curriculum Reform in Secondary School Science and Social Studies." The manual includes three sets of tools for these trainers: (1) a guide to designing training programs to support implementation of STS; (2) a selection of activities for use in training sessions; and (3) reference materials on STS teaching strategies. Chapter 2 discusses strategies for designing STS training programs and covers awareness sessions, inservice workshops, and trainer-of-trainers sessions with special emphasis on developing objectives. Chapters 3-6 contain a range of training activities divided into four categories: (1) activities that introduce STS, focusing on what it is and why it is important; (2) activities that help teachers integrate STS into their curricula; (3) activities that help teachers develop action plans for implementing STS; and (4) activities for evaluating STS programs. Each training activity includes background information for the trainer, required materials, handouts, objectives, and procedures. The appendices comprise nearly one-third of the document and contain transparency masters for the training sessions and teaching strategies for STS. (DJC)

SCIENCE TECHNOLOGY SOCIETY

TRAINING MANUAL

By Laurel R. Singleton

SOCIAL SCIENCE EDUCATION CONSORTIUM, INC.

SCIENCE/TECHNOLOGY/SOCIETY: TRAINING MANUAL

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1988

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1. INTRODUCTION

Importance of Education on Science/Technology/Society

In a democracy, citizens have the right and responsibility—as voters, consumers, workers, and office holders—to participate in decisions about issues related to social uses of science and technology. The success of individuals and their society is tied to the quality of these choices, which varies with the knowledge and cognitive skills of decision makers. The vitality of our American democracy depends upon widespread ability of citizens to think effectively about developments in science and technology and their effects on the world. Therefore, a central mission of American schools should be education on science and technology in a social context.

Thus, the position statement on science, technology, and society, adopted by the National Science Teachers Association in 1982, states, in part: "Many of the problems we face today can be solved only by persons educated in the ideas and processes of science and technology. A scientific literacy is basic for living, working, and decisionmaking in the 1980s and beyond."[1]

Similarly, the position statement developed by the Science and Society Committee and adopted by the National Council for the Social Studies Board of Directors in 1982 states: "The impact of science and technology upon society, be it an environmental impact study, the energy problem, or other timely occurring issues, indicates a need for social studies and science educators alike to develop guidelines for teaching about science-related social issues. Science is a social issue, and the examination of scientific issues offers an excellent opportunity for helping students develop a synthesized perspective on science-related issues, a synthesis of the technical data coupled with social, political, economic, ethical, and philosophical information."[2]

These two position statements give major responsibility for education about social issues related to science and technology to teachers. Teachers must rethink the role they play in the development of STS education, particularly in reflecting the constant shifts in values, the need for an increased knowledge base, and the implementation of processes that convey knowledge while including students in active, participatory learning

The introduction of STS issues and themes into the science and social studies curricula offers unique opportunities to achieve these goals. Whether STS is infused into an existing course or used as the foundation for a course, STS content should be presented so as to encourage students to think about the social and personal implications of the issues.

Purpose of This Project

To help educators meet this challenge, the Social Science Education Consortium has undertaken a project entitled "Building Support Networks for Improved Science/Technology/Society Education." Funded by the National Science Foundation, the project has developed a series of STS resources helpful to both science and social studies educators.

Science/Technology/Society: A Framework for Curriculum Reform in Secondary School Science and Social Studies provides a guide for designing units of study that integrate knowledge from science and social studies. Included are guidelines for selecting STS content, developing skill in analyzing STS issues, developing positive attitudes toward science and technology, assessing options for the design of STS curricula, and infusing STS into secondary science and social studies courses. The *Framework* also presents a powerful rationale for the STS curriculum movement.

This volume, *Science/Technology/Society: Training Manual*, can be used by teachers, department chairs, curriculum supervisors, and other educators to design a training program covering the following phases of program development: building a rationale for STS, determining the most appropriate fit for STS issues in the curriculum, developing an integrated approach for teaching about STS issues, selecting and developing STS materials, and evaluating the STS program.

Science/Technology/Society: Model Lessons for Secondary Social Studies Classes and *Model Lessons for Secondary Science Classes* exemplify the guidelines provided in the curriculum framework and training manual. Although the lessons were designed for infusing STS topics into the science and social studies curricula, they could also be grouped to create an STS unit or be combined with other materials to form the basis for an STS course. Many of the activities are extant lessons identified as dealing with STS issues and themes. For each such activity, the original source is listed, thus enabling the user to locate additional materials with potential STS emphasis. Other lessons were developed by project staff to ensure at least modest coverage for each of the courses within the science and social studies curricula. There is some overlap between the two volumes. However, users will find that some lessons provided only in the social studies volume, for example, are also useful in science classes.

An order form for all the project publications and related STS materials is provided at the end of this book.

Organization of the Training Manual

This volume is designed to help trainers—whether state-level coordinators, university teacher trainers, district coordinators, or lead teachers—implement the guidelines provided in *Science/Technology/Society: A Framework for Curriculum Reform in Secondary School Science and Social Studies*. To that end, the manual includes three sets of tools for trainers: (1) a guide to designing training programs to support implementation of STS; (2) a selection of activities for use in training sessions; and (3) reference material on STS teaching strategies.

Chapter 2 discusses strategies for designing training programs in support of STS implementation; a range of training sessions—including awareness sessions for administrators and school boards, inservice workshops for teachers, and trainer-of-trainers sessions—are covered. Special emphasis is placed on setting objectives for training and matching activities with those objectives.

Chapters 3-6 contain a range of training activities divided into four categories: (1) activities that introduce STS, focusing on what it is and why it is important; (2) activities that help teachers fit STS into their curricula; (3) activities that help teachers develop action plans for implementing STS, including working with colleagues in other departments (i.e., working interdisciplinarily between science and social studies); and (4) activities on evaluating STS programs.

The training activities are presented in a standard format; each includes background for the trainer, a list of materials needed, activity objectives, and suggested steps for using the activity, including instructions for debriefing. Masters for workshop handouts are provided as appropriate. Transparency masters, because they are used in more than one activity, are presented in Appendix A.

The final section of the manual (presented in Appendix B) provides brief descriptions of activity-oriented instructional strategies appropriate for use in STS. Input from science educators, in particular, has indicated lack of familiarity with many such strategies. Consequently, training activities and materials may well be appropriate. For each strategy covered, the manual provides a brief narrative; a black-line master (for overhead and/or handout), generally in checklist, chart, or other graphic form; and cross-references to the model lesson volumes.

Notes

1. National Science Teachers Association, *Science-Technology-Society: Science Education for the 1980s* (Washington, DC: NSTA, 1982).

2. Science and Society Committee of the NCSS, "Guidelines for Teaching Science-Related Social Issues," *Social Education* 47 (April 1983), p. 258.

2. DESIGNING A TRAINING PROGRAM

This *Training Manual* has many potential users with different objectives and different degrees of commitment to STS education. The audiences for whom they will be conducting training sessions will differ as well. Thus, we cannot address all the variables that every user must deal with in planning a training program. However, certain steps must be taken in planning any session; the sections that follow cover those steps, examining special considerations in planning awareness sessions, infusion training sessions, course planning sessions, and training-of-trainers sessions.

Identifying the Audience

Identifying the audience—whom you are trying to reach—is a key first step in planning any training session. Appropriate audiences will likely vary depending on the type of session you are planning and the decision-making process in the district in which you are working. However, some general considerations can be stated for each kind of training session.

Awareness Sessions. Awareness sessions are designed to develop general knowledge of what STS is and why it is important. Potential audiences include administrators and policy makers (such as school boards), curriculum coordinators, teachers, and community representatives. Each of these audiences has a role to play in encouraging or preventing innovation, so planning some awareness activities for each is a good idea. For example, because administrators and policy makers can "make or break" an innovation, it is important to develop their awareness of STS as a first step in gaining support for the change.

Similarly, discipline supervisors (if present in a district) can be helpful in a number of ways—developing instructional materials, initiating staff development, and directing the efforts to include STS in the district's long-range program objectives. Staff supervisors are also critical in determining teaching assignments, equalizing course loads, resolving conflicts, and selecting staff to participate in new courses or projects. Thus, early exposure of discipline and staff supervisors to an awareness session—leading to early buy-in and commitment to STS—is critical.

Those expected to implement STS—teachers—must understand what STS is and why it is important before they can plan to incorporate it in the curriculum. Thus, a separate awareness session should be scheduled for teachers, or a portion of a longer training program should be set aside for introductory awareness activities.

Finally, the support of various community groups may also be important in implementing STS, particularly if the program will include extensive community work by students or analysis of issues that are controversial. Thus, while awareness sessions for community groups may be important, these may be conducted later in the implementation process, when the nature of the program being implemented is fully defined.

Infusion Training Sessions. The key audience for infusion training sessions is teachers—science, social studies, or both. However, inviting building-level administrators and curriculum coordinators to portions of the training may also be politic. Furthermore, if materials will be selected as part of the training, district guidelines for materials selection should be followed; if guidelines call for parent input, for example, you must be careful to include parents in this portion of the training.

Course Planning Sessions. Like infusion sessions, the key audience for course planning sessions is teachers. Because of the interdisciplinary nature of an STS course, teachers from both disciplines should be included in the sessions. Again, attendance by administrators, curriculum coordinators, and community representatives may be advisable.

Trainer-of-Trainers Sessions. Depending on the level at which a trainer-of-trainers model is being implemented—state, regional, or local—the designated trainers may vary. However, they should include instructional leaders with some training experience – curriculum coordinators, department chairs, lead teachers, and the like.

In identifying audiences for any of the kinds of training discussed here, it may be useful to employ a team approach; for example, asking each school participating in a district training to send a team of science and social studies teachers helps build a collegial network that will enhance chances for change occurring in the school after training.

Setting Objectives

Setting clear objectives for a training session is probably *the* most important aspect of planning. In setting objectives, you must consider the time available for the training and the resources available for providing follow-up support to participants. Both of these factors may place constraints on how much can be accomplished or how much can be expected as a result of training.

Some sample objectives for various kinds of training programs are given below.

Awareness Session:

- To demonstrate the importance of science, technology, and their impacts on society in participants' own lives.
- To demonstrate the relationship between STS and what students will need to know and be able to do as adult citizens.
- To familiarize participants with the rationale for STS education
- To make participants aware that STS can be implemented through infusion or creation of new courses.
  (See Chapter 3 for related activities.)

Infusion Training Sessions (all of the above objectives plus):

- To help participants identify goals for infusing STS into the curriculum.
- To identify links between STS content, skills, and attitudes and current curriculum.
- To help participants become skilled at evaluating STS materials and lessons.
- To demonstrate the range of teaching strategies that can be used in STS
- To teach participants a process for developing STS lessons or units.
  (See Chapter 4 and Appendix B for related activities and materials)
- To demonstrate in a nonthreatening way the potential for interdisciplinary planning and teaching.
- To help participants develop an implementation/action plan for STS.
  (See Chapter 5 for related activities.)
- To provide participants with the skills needed to evaluate their STS program
- To provide participants with tools for evaluating student learning in STS.
  (See Chapter 6 for related activities.)

Course Planning Sessions:

- To help participants identify goals and objectives for an STS course.
- To engage participants in the initial steps in content selection.
- To demonstrate in a nonthreatening way the potential for interdisciplinary planning and teaching.

- To help participants develop an implementation/action plan for STS. (See Chapter 5 and Appendix B for related activities and materials.)
- To provide participants with the skills for evaluating STS materials and lessons.
- To teach participants a method for developing STS lessons or units. (See Chapter 4 for related activities.)
- To provide participants with the skills needed to evaluate their STS program.
- To provide participants with tools for evaluating student learning in STS. (See Chapter 6 for related activities.)

Training of Trainers (all of the objectives for Awareness and Infusion Sessions plus):

- To help participants develop a plan for conducting local inservice training.

Making Logistical Arrangements

Three simple, but often neglected, factors must be considered in making logistical arrangements: (1) setting an appropriate time and date for the session, (2) finding a suitable room, and (3) insuring that all needed equipment is available and functioning. In scheduling awareness sessions, which are generally relatively brief (15 minutes to two hours at most), it is often advisable to include the presentation as part of another meeting that the targeted audience will be attending—a school board meeting, social studies or science team meeting, a professional conference, etc. Other training sessions, which will require a longer time commitment, require careful scheduling to ensure maximum participation. Whenever possible, of course, providing released time for teachers so that the training can be held during the school day is the most reliable method of assuring high participation. If this is not possible, however, the trainer should work with representatives of the target group and administrators to achieve the most advantageous scheduling.

For the kinds of training activities presented in this manual, a flexible meeting space with movable work tables and chairs is needed. The trainer is well advised to make these requirements known to whoever makes such arrangements in the district. In any event, the trainer should visit the assigned meeting room prior to the training session so adjustments can be made if necessary.

Similarly, it is advisable to bring your own audiovisual equipment or to test the equipment provided enough in advance of the session to make repairs or other adjustments if necessary. A presentation that relies on overheads can be seriously undermined by a burned-out bulb.

Conducting the Training

In conducting the training, there are several considerations to keep in mind. First, demonstrating lessons is an effective technique only if the lessons being demonstrated serve the objectives of the training session. When they do, not only will you achieve the objectives, but you will also have provided participants with an idea they can implement in their classrooms.

Too often, however, trainers demonstrate activities without thinking through their relationship with the overall objectives or without helping participants draw out the connections. The importance of debriefing activities thoroughly cannot be overemphasized. Indeed, trainers must keep in mind the levels at which activities should be debriefed. For a teacher-training session in which classroom activities are demonstrated, the activity should be debriefed at two levels:

- How does this activity work in the classroom? How would it need to be adapted to fit your needs? How could it be expanded or improved?
- How does this activity demonstrate a key point about STS education (e.g., the importance of STS to students' future decision-making as citizens or the applicability of nontraditional teaching techniques to STS content)?

For a training-of trainers session, yet another level of debriefing must be added.

- How would this activity work in a teacher-training session in your district? What points can it be used to make?

Not only does well-planned debriefing help participants make inferences based on the activity and plan for their own use of the activity, it allows them to be proactive in suggesting improvements to the activity—for their own and their colleagues' use, as well as the trainer's.

It may also be helpful to keep in mind that while STS content is unfamiliar enough to most participants that they will be able to learn something from many of the activities provided in the *Model Lessons* volumes, it is generally wise to treat participants as adult learners and not ask them to assume the role of their students. Doing so may offend some participants and may distract attention from the objectives of the training activity.

A final caution, which perhaps seems too obvious to mention but is nonetheless often ignored in conducting training programs: Do not let your zeal to accomplish a long series of objectives compel you to work the group too hard. Breaks and some informal conversation time are essential and will in the long run increase productivity.

Evaluating the Training

In most instances, the trainer will want to determine through the evaluation the degree to which training activities achieved their objectives and the kinds of follow-up support participants identify as being needed. Thus, the evaluation and its instruments will derive directly from the training objectives.

Surveys or interviews are usually the most cost-effective means of collecting data about your training activities. Each approach has strengths and weaknesses. Surveys are excellent for collecting data from large numbers of individuals, but they often lack the detail and depth necessary for understanding why respondents answered as they did. Interviews provide detailed information but are costly and time-consuming when applied to large numbers.

While it is easiest to collect data immediately after the training activity and such an exercise is certainly appropriate, trainers might also administer a survey or interview a sample of participants after they have had an opportunity to apply what they learned. Time to reflect and apply what was learned in training can produce different responses and suggested improvements, which might be extremely helpful in designing future programs and in planning follow-up assistance. Thus, if resources are available, trainers might consider a time series evaluation model in which assessments are conducted several times.

In constructing your evaluation instrument, you will need to decide whether to use an open or closed format; this refers to whether the respondent must select from two or more response choices provided (closed format) or can simply respond in his/her own words (open format).

A Likert scale is a forced-choice technique that provides an avenue for measuring the strength of respondents' feelings. Likert scales consist of a set of statements that participants are asked to respond to by indicating the extent to which they agree or disagree (e.g., strongly agree, agree, neutral, disagree, strongly disagree).

While forced-choice techniques have the advantage of providing information that can be easily subjected to statistical analysis, these approaches are relatively weak with regard to explanatory power. For example, you may learn that participants don't intend to use community resource persons, but you won't know why. They may not feel comfortable with the strategy, they may not have time to locate appropriate persons, or school policy may inhibit having community persons in classrooms. Without additional information, you cannot identify which explanation is correct. Therefore, forced-choice formats are often more powerful when accompanied by open-ended questions. For example, a forced-choice item, supplemented by an open-ended question, might be:

I learned how to plan an STS wo.kshop for teachers.

Strongly agree 1 2 3 4 5 Strongly disagree

Please explain your answer. If you disagree, please indicate what additional assistance would be helpful.

Together, these questions not only provide a basis for a statistical analysis of this aspect of the training program but also explain the statistical data and provide formative data for program improvement.

After you have selected the format you wish to use for your data collection, you must write the individual items very carefully. The following suggestions – while not comprehensive – are intended to help trainers write items that will generate accurate, valid, and useful data:

- Keep questions simple. Use syntax and vocabulary that are easy to understand.
- Avoid combining two issues. For example, the following Likert scale question would be better written as two questions, with one focusing on classroom use and one focusing on sharing: "I expect to apply what I learned in this workshop in my class and to share it with colleagues." Participants who will share, but not use, what they learned (or vice versa) cannot make a response to this question that provides accurate and useful data.
- Avoid loaded questions or ones that contain terms that might bias responses. For example, by indicating what school policy is, the following question may influence some persons to respond positively: "School policy mandates that STS be included in the civics and general science courses. Do you agree?" A better way of phrasing the question would be: "Do you agree that STS should be included in civics and general science courses?"
- Do not word items in a manner that suggests that certain responses are more acceptable than others. When interviewing, respond in a similar manner to all responses. Head nodding or words of encouragement when respondents offer positive assessments will encourage additional similar responses and decrease negative ones.
- Avoid negatively worded items, such as: "Do you agree that the district has not provided enough staff development in the area of STS?" A better item would be. "Do you feel that the district has provided enough staff development in STS?"

The layout of written instruments can also influence results. The general appearance should convey a sense that completing the instrument is easy. Items should be clearly separated, with sufficient space provided so that they do not appear to be crowded together.

The instrument should begin with a brief explanation of how responses will be used, followed by clear, concise directions for completing the instrument. The first items should be nonthreatening questions; you can then progress toward more challenging ones. Items that deal with related topics should be grouped together.

When you have collected your data, you should analyze it to determine where the training program needs to be strengthened and what follow-up support is available. If resources are not currently available for follow-up, a well-written evaluation summary may help justify expenditure of such resources.

For forced-choice items, simple tabulation of responses by type should be done immediately; that is, indicate how many persons selected A, B, C, and D. If percentages or mean scores are helpful, these should also be calculated. Means, percentages, and absolute scores can be converted to charts or graphs in final reports.

For open-ended responses, it is most helpful to read all of the responses to a particular question with the idea of looking for categories of responses. After an initial review of the responses, you may identify several general categories of responses. During secondary analysis, assign each response to one of these categories and make note of exemplary comments for each category. The number of responses in each category and the strength of feelings expressed are useful explanatory data. These groupings can be converted to numerical scores for reporting, with "typical" comments used to illustrate the responses in each category.

Compare the results of the forced-choice items with the open-ended items in preparation for writing your summary of the data. In preparing your summary, it is best to let the data speak primarily for itself; don't overgeneralize!

3. INTRODUCING STS

General training objectives addressed by the activities in this chapter include:

- To demonstrate the importance of science, technology, and their impacts on society in participants' own lives.
- To demonstrate the relationship between STS and what students will need to know and be able to do as adult citizens.
- To familiarize participants with the rationale for STS education.
- To make participants aware that STS can be implemented through infusion or creation of new courses.

WHERE IS STS IN MY LIFE?

Background Notes

Science and technology are powerful social forces and generators of critical public issues. One strategy for helping educators begin to develop a rationale for including STS in the curriculum is to make them aware of how science and technology affect their own lives. That is one of the aims of this activity. A second aim is to help educators more clearly define the three components of STS education—science, technology, and society—and think about the interactions among these components.

Three alternative strategies for presenting the activity are described. The first—Technology Mind Walk—is the least involved and can probably be completed in 15 minutes or less. The second—Technology Timeline—takes only slightly longer and may work particularly well if participants will be coming into the session over a period of several minutes. The final option—Ten Inventions That Changed Our Lives—is the most involved and will likely take 30 to 45 minutes to complete. Other activities from the model lessons volumes might be adapted to fit the purposes of this training activity as well; these would include "STS in My Life" (Lesson 9 in both volumes) and "Bumper Sticker Position Statements" (Lesson .1 in both volumes).

Whatever strategy is used to help educators assess the importance of STS in their own lives, the activity should be debriefed by focusing on definitions of the components of STS and the process of rationale development. Two transparencies based on the *Framework for Curriculum Reform in Secondary School Science and Social Studies* are provided (see Appendix A) for use in the debriefing.

Conducting the Activity

Materials Needed: Technology Mind Walk—posting paper, tape, markers; Technology Timeline—butcher paper timeline marked from 1920 to 1990, tape, markers, three colors of 3" x 5" cards; Ten Inventions That Changed Our Lives—sufficient copies of Handouts 1 and 2, posting paper, tape, markers; all options—Transparencies A and B, overhead projector.

Activity Objectives: Participants should be able to (1) list five ways in which STS interactions and issues affect their own lives, (2) define the three components of STS—science, technology, and society, and (3) describe a rationale for STS education.

Suggested Steps:

1. Tell participants that the first step in planning for STS education is to begin thinking about a rationale for including STS in the curriculum. You may want to use this introductory statement: A rationale reflects the "why" of the program. It includes statements about the nature of our students, our views of society, and our views of science and technology. It serves as a guide to the development of broad program goals, student learning outcomes, and content. It is also a guide to the way we work with students in the classroom. The rationale can be used to help explain the nature of the program to the public. This activity is designed to help us begin to think about why we should be teaching about science, technology, and society. (Note: If you have elected the Technology Timeline option, you will be having participants begin filling out their cards as they enter the room, but you should still give this introduction to the activity when all the participants have arrived.)

2. *Technology Mind Walk*

Ask each participant to write a list of everything he/she has done since getting up this morning. You may clarify by giving some examples. After each participants has about ten items listed, ask them to identify the technologies associated with the various activities. Ask participants to share their activity/technology pairs and brainstorm others. As with any brainstorming activity, do not quit when participants first "run down." Instead, ask some probing questions to get them started again.

When the group has compiled a lengthy list, ask them if they can identify scientific discoveries/breakthroughs that were necessary to make each technology possible. It is not necessary to go through ten complete lists of technologies for this step; a sample of five or six items is probably sufficient.

Then ask the group what the list shows about the effects of technology on our lives. Have the group identify ways in which several of the technologies have affected society. Have most of the technologies been helpful? Have some had harmful effects as well? What does this suggest about the importance of studying STS?

Point out that each technology with which participants have come into contact today represents interactions among science, technology, and society. These interactions are at the heart of STS education.

or

2. *Technology Timeline*

As participants enter the room where you will be holding the workshop, give them three notecards; each notecard should be a different color. Instruct participants (you may want to write these instructions on posting paper) to write on one notecard the first national or international news event they remember; on the second card, they should write the first issue in which they became involved politically; on the third card they should write the first new invention they can remember wanting to own. They should write a year on each card and then tape their cards to the timeline you have posted in the room. Latecomers can complete their cards while you are making your introductory remarks.

Allow time for participants to examine all the cards on the timeline. Then discuss what the timeline shows, examining such questions as:

- How many of the events people remember involved science or technology? Were science and technology more likely to be elements of the events of the younger participants? Through what technology did they learn about the event?
- What were the first new inventions people remember wanting? Have all of these new technologies had only positive effects or have they had negative effects as well (even though participants wanted them)?
- How might answers for students be different? What does this say about how our society is changing?

Point out that many of the events people listed represent interactions among science, technology, and society. These interactions are at the heart of STS education.

or

2. *Ten Inventions That Changed Our Lives*

Divide the group into several smaller groups of three or four. Distribute Handout 1 and allow approximately 20 minutes for reading and discussion. Have groups post their responses to each question on a separate piece of posting paper. At the end of the discussion period, post all of the sheets for question 1 together, all of the sheets for question 2 together, and so on. Debrief by going over the posting sheets and allowing participants to expand on differences of opinion reflected there.

Point out that the discussion highlighted interactions among science, technology, and society. Tell participants that they will have a chance to graphically represent some of these interactions by using

Handout 2. Distribute the handout and allow about 5 minutes for individual work. Rather than going over the webs in detail, stress the complexity of the relationships that participants identified. These complex interactions are the heart of STS education.

3. Project Transparency A and discuss the definitions and diagram provided. You may wish to use this information from the *STS Framework* in discussing the interactions:

Interaction: SCIENCE – > TECHNOLOGY. The knowledge generated by the scientific enterprise plays an important role in shaping technologies. Our technological limitations are more often products of limited knowledge than inadequacies in engineering skills.

Interaction: SCIENCE – > SOCIETY. The knowledge generated by science influences individual and collective action. Examples of this extremely obvious and infinitely powerful relationship abound. Consider, for example, the social consequences of the compass or gunpowder. In a more contemporary sense, the social consequences of advances in physics, biology, and health are evident.

Interaction: TECHNOLOGY – > SCIENCE. New technologies shape the scientific enterprise, often determining the questions that are asked and the means that are employed in seeking answers. This often-overlooked or underestimated interaction has grown to unanticipated proportions in recent decades. Just as Leeuwenhoek could not observe unicellular organisms until he developed sophisticated magnifying lenses, so scientists today are limited in their inquiries by the tools available to them. On the brighter side, we sometimes develop tools that expand our vision into undreamed-of domains--the use of computers for brain scanning being only one of the many recent and notable examples. For better or for worse, "pure science" is becoming increasingly rare. While some scientists are still seeking knowledge for its own sake without regard to possible futu. applications, their work is seldom funded without an eye to future technologies. For example, today's basic research in cell biology is a direct result of concerns about cancer. Work on light is supported by interests ranging from the medical applications of fiber optics to the military applications of laser weapons.

Interaction: TECHNOLOGY – > SOCIETY. Technology has profound influences on how people act and interact locally, nationally, and globally. Perhaps the most misunderstood and maligned of all the interactions, this is perhaps also the most visible and the most rapidly changing from the viewpoint of the average citizen. Care must be taken to avoid one-sided, emotional indictments when, for example, modern fertilizers are blamed for polluting the water while their contribution to increased food production is overlooked or discredited. Technology per se is neither friend nor foe—but positive and negative consequences are unavoidable. The challenge is to anticipate both and then take steps to minimize undesired outcomes. Such choices fall within the decision-making purview of individuals (e.g., safe use of contraceptive technologies), organized groups (e.g., citizens' action and lobby groups for environmental or consumer protection), and nations (e.g., the debate over nuclear weapons systems sent orbiting in space).

Interaction: SOCIETY – > SCIENCE. Individual and collective opinion and action often determine how the course of scientific research will proceed. In any human system, the total available resources are always less than the total required to meet the needs and wants of all the components of the system. Thus, much scientific research goes unfunded, because society believes some questions to be more important than others. Often, a concern for possible future applications is the arbiter, and promising areas of inquiry that could generate significant leaps in understanding lay idle and forgotten. Public opinion also restrains research procedures. Examples include the action of the Cambridge City Council to ban recombinant DNA research in that municipality and the continuing efforts of animal protection groups to outlaw research on mammals, vertebrates, or all animals.

Interaction: SOCIETY– >TECHNOLOGY. Individuals and groups of human beings make choices about what new technologies will be developed and how they will be employed. From the perspective of the average citizen, this interaction may appear magical if it exists at all. In fact, new technologies frequently seem to arise from nowhere–absent one day and mysteriously omnipresent the next. Only upon careful, detailed examination of histories, trends, and decision trails does it become possible to delineate the chain of human-controlled causes and effects that lead to the deceptively "overnight" appearance and widespread adoption of new technologies.

What must be emphasized with students is that, at every point along the way, people make decisions to create and disseminate new technologies. Scientists select a simple research area from the thousands available to them. Companies, government agencies, or both invest in engineering, development, and testing. Financial institutions arrange venture capital. Marketing specialists identify those most likely to buy, and advertising experts determine ways to persuade the potential buyer. Manufacturers determine cost-effective production schemes. Distributors identify means of bringing products to the retail marketplace. Finally, consumers decide whether, when, and how they will use new technologies. The decision of the user provides the feedback that completes the system. This scheme of bringing consumer technologies to market differs only slightly from the pattern employed to deliver large-scale technologies, most notably weapons and defense systems, for collective uses.

Interaction: SCIENCE– >TECHNOLOGY– >SOCIETY. These interactions may be either mutually reinforcing or mutually exclusive and may, furthermore, create desirable or undesirable outcomes seen as risks, benefits, gains, losses, advantages, or disadvantages. The patterns of thought typically described by "cost-benefit analysis" and "risk-benefit analysis" are no longer seen as complex, technical tools accessible to only a few. Seeking answers to such questions as "What do I have to gain?" and "What do I have to lose?" is an activity of merit for every citizen and every student. The answers to these questions can be ascertained only through detailed study of situation-dependent interactions between and among science, technology, and society.

4. Ask participants to reflect on how what they have discussed in this activity informs the development of a rationale for STS education. Post their responses and save them for analysis later in the training session.

5. Project Transparency B and briefly go over the rationale it presents for STS education. Be sure participants understand that they can develop their own rationales as they plan their program. This is merely a starting point for that process.

THE CONSUMER HIT PARADE

Directions: Read the material that follows and discuss the accompanying questions in your group. Write the group's response to each question on a separate sheet of posting paper.

In the October 6, 1986, issue of *Newsweek*, Robert J. Samuelson described the ten products or services that he believed had changed post-war American society most profoundly, resulting in a "society of greater individual choice and mobility without many of history's wants and discomforts."

Samuelson's list included the following ten items:

- Television: "TV has surely changed politics; it brought the Vietnam War into living rooms. It's also expanded national culture ..."
- Jet Travel: "It has shrunk the country."
- The Pill: "Along with working women and better appliances – subverted old sex roles."
- Air Conditioning: "It made the sun belt possible."
- Automatic washers and dryers: "They revolutionized housework."
- Antibiotics: "Drastically reduced the threat to life of commonplace injuries and infections."
- Health Insurance: "It made health care an entitlement."
- Long Distance: "It too has shrunk America."
- Social Security and Pensions: They made retirement "an expected part of life."
- Interstate highways: "They've shaped suburbia by attracting offices, malls, and industrial parks, determining where we live, work, and shop."

Samuelson's list did not include computers. He characterized computers as one of the products "that mainly serve business" and therefore "don't count."

1. Explain why you agree or disagree with Samuelson's decision to omit computers from the list.

2. What items missing from Samuelson's list do you feel should be included?

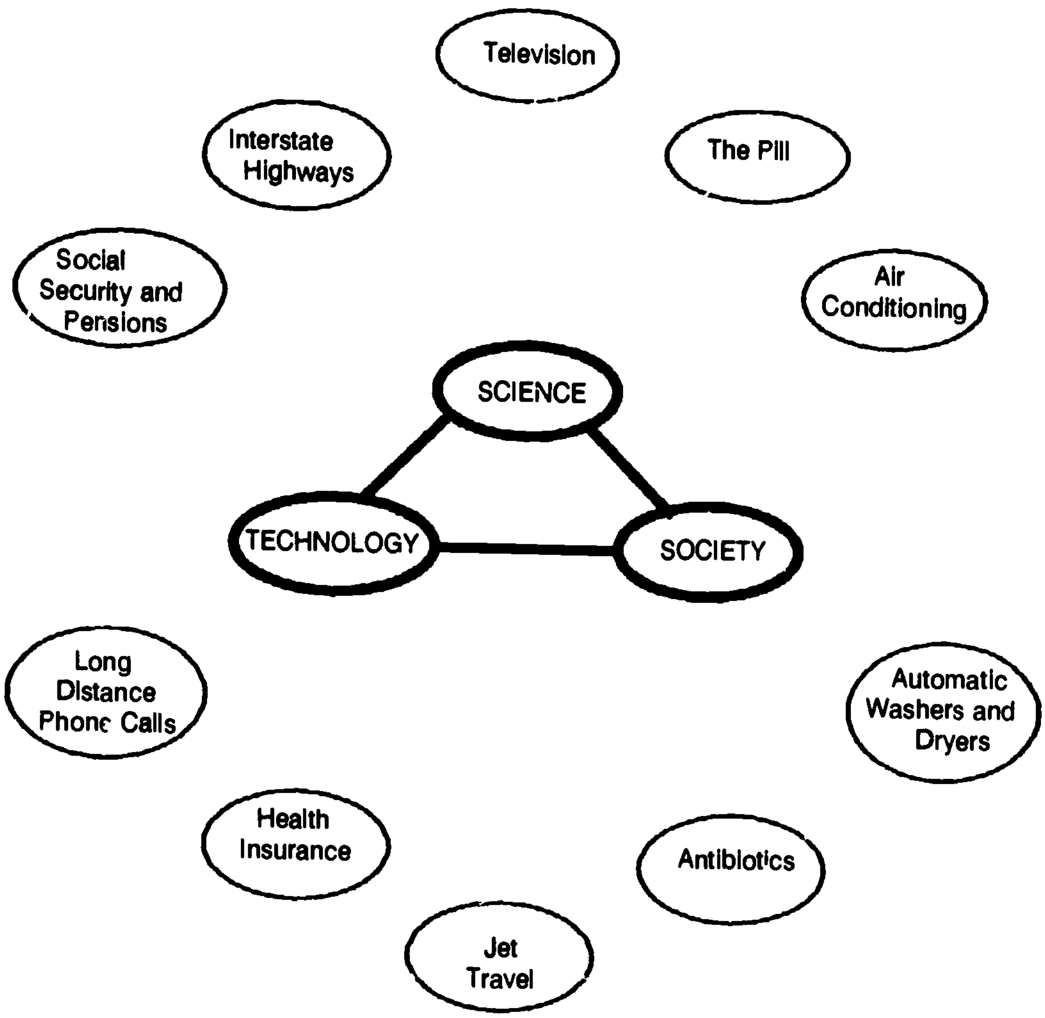
3. Which items do you think he should have omitted?

4. For each "Consumer Hit," identify one scientific discovery that laid the groundwork for the development of that item.

5. Pick one of the items and list one positive and one negative effect that item has had on society. Be prepared to explain your examples.

THE WEB OF SCIENCE, TECHNOLOGY, AND SOCIETY

Directions: Draw a line from each consumer item to the categories you feel are directly connected to it. With a different type of line or a different color pen, connect all of the consumer items that you feel are related or have mutual interactions.



WHERE IS STS IN MY STUDENTS' LIVES?

Background Notes

In a rapidly changing and increasingly interdependent world, educators are being forced to make critical and difficult decisions as to what should be taught to prepare students for the world of today and the world of tomorrow. The purpose of this activity is to let teachers work through their own thoughts as to what knowledge, skills, and attitudes their students will need to live successfully in the year 2000.

Participants begin by completing a worksheet that asks them which of 11 forecasts for the year 2000 they think will happen. They then work in small groups, using the worksheet list to generate lists of knowledge, skills, or attitudes needed to live successfully in the future. Following the small-group activity, the participants assess whether the items are part of their own instructional program and compare them with the goals of STS.

An alternative to this activity that would address the same objectives is "The Futures Wheel" (Lesson 4, *STS: Model Lessons for Secondary Science Classes*). You could adapt this lesson by having participants, when they have completed the futures wheels in their small groups, think about the knowledge or skills students will need to cope with all the consequences identified on the wheels.

Conducting the Activity

Materials Needed: Sufficient copies of Handout 3; one copy of Transparency C and overhead projector; newsprint, marking pens, and masking tape.

Activity Objective: Participants should be able to (1) list important educational goals (knowledge, skills, and attitudes), (2) evaluate their program in terms of whether it is addressing those goals, and (3) link the goals with those of science/technology/society education.

Suggested Steps:

1. Explain that while the last activity focused on importance of STS today, a rationale for STS also must consider future needs for students. Distribute Handout 3. Ask participants to complete the survey by reading each statement and noting their responses in the columns on the right side of the page.

2. When participants have completed the survey, select four to six of the survey items and ask for a show of hands for the two responses. For those items where disagreements occur, ask participants for their reasons for choosing one response or the other, thereby generating discussion on the item.

3. Following discussion of a few of the items, ask participants to write down how old their students will be in the year 2000. Ask what they feel students will have to know, be able to do, and believe in order to successfully live in the year 2000.

4. Divide participants into groups of four or five. Assign each group one of the major topics: knowledge, skills, or attitudes. Ask each group to brainstorm a list of items that they feel students will have to know, do, or believe in order to live successfully in the year 2000. Ask one participant in each group to list the responses on a piece of poster paper.

Adapted from *Teaching About the Future: Tools, Topics, Issues*, by John D. Haas and others (Boulder, CO: Social Science Education Consortium, 1987).

5. Following the brainstorms, ask each group to post its responses and to read them to the rest of the group. Allow for clarification questions; seek additions to each of the three lists.

6. Ask participants to evaluate the lists in two ways:

- Review each item and mark it S (strong) or W (weak) to indicate their own level of competency.
- Review each item and assign a Y (yes) or N (no) to indicate whether the item is part of their teaching at present.

7. Project Transparency C, which shows the components of STS. Ask participants to indicate which items on their lists of goals could be subsumed under science/technology/society education. Conclude the activity with this quotation from the American Association for the Advancement of Science: "The gap between the public's understanding of science and technology and the requirements of citizenship in a participatory democracy will continue to widen."

FORECASTS FOR THE YEAR 2000

Each statement below describes a possible condition in the year 2000. For each statement, mark the right column indicating whether you think it will or will not happen.

		Will Happen	Will Not Happen
1.	The present U.S. population of 230 million will have increased much more slowly than the population of the world; U.S. population will not be more than 260 million.	______	______
2.	Population will have grown faster than the ability to produce food; in some parts of the world, millions will be dying of hunger.	______	______
3.	American per capita income will have doubled from $10,500 in 1981 to $21,000 (in 1981 dollars).	______	______
4.	Per capita income in the developing nations will have doubled from $300 to $600.	______	______
5.	Many of the countries that were still "developing" in the 1980s will have industrialized.	______	______
6.	Air and water pollution levels throughout the world will be high because nations industrializing and modernizing agriculture could not afford pollution controls.	______	______
7.	Global reserves of many important nonrenewable natural resources such as petroleum, natural gas, aluminum, copper, lead, and tin will be almost exhausted.	______	______
8.	Nuclear power will be supplying at least one-half of U.S. energy requirements and will be expanding.	______	______
9.	Several serious accidents involving radioactive contamination of the surrounding areas will have occurred at nuclear power stations.	______	______
10.	Almost all nations will possess nuclear weapons.	______	______
11.	We will routinely receive television broadcasts from most countries of the world via satellite.	______	______

KEY REFERENCES ON A RATIONALE FOR STS EDUCATION

Bybee, Rodger W., "The Sisyphean Question in Science Education: What Should the Scientifically and Technologically Literate Person Know, Value, and Do—As a Citizen?" in Rodger W. Bybee, ed., *Science/Technology/Society* (Washington, DC: National Science Teachers Association, 1985), pp. 79-93.

"Guidelines for Teaching Science-Related Social Issues," *Social Education* (April 1983), pp. 258-261.

Hickman, Faith M., John J. Patrick, and Rodger W. Bybee, *Science/Technology/Society: A Framework for Curriculum Reform in Secondary School Science and Social Studies* (Boulder, CO: Social Science Education Consortium, 1987).

Hurt, Paul DeHart, "Perspectives for the Reform of Science Education," *Phi Delta Kappan* (January 1986), pp. 353-358.

McConnell, Mary C., "Teaching About Science, Technology, and Society at the Secondary School Level in the United States: An Educational Dilemma for the 1980's," *Studies in Science Education* 9 (1982), pp. 1-32.

Roy, Rustum, "The Science/Technology/Society Connection," *Curriculum Review* (January/February 1985).

Rubba, Peter, "Perspectives on Science-Technology-Society Instruction," *School Science and Mathematics* 87 (March 1987).

Science-Technology-Society: Science Education for the 1980's, NSTA Position Statement (Washington, DC: National Science Teachers Association, 1982).

4. FITTING STS INTO THE CURRICULUM

General training objectives addressed by the activities in this chapter include:

- To help participants identify goals for infusing STS into the curriculum.
- To identify links between STS content, skills, and attitudes and current curriculum.
- To help participants become skilled at evaluating STS materials and lessons.
- To demonstrate the range of teaching strategies that can be used in STS.
- To teach participants a process for developing STS lessons or units.

WHERE DOES STS FIT IN THE CURRICULUM?

Background Notes

STS can be implemented in at least three ways;

- STS topics or themes can be infused into existing lessons or units, enriching study of topics that are already covered by looking at them through a new prism.
- Separate STS lessons or units can be developed for use in existing courses. Something must be removed in order to free time for the lesson, but once again, the structure of the course—while expanded—remains essentially unchanged.
- A separate STS course with unique objectives and content can be added to the curriculum. Such a course may reside within the science or social studies program or may be interdisciplinary, drawing on both science and social studies teachers.

This training activity focuses on the first two options. The third option is addressed in the next chapter, although providing training on all the steps in the process of developing an entirely new course is beyond the scope of this training manual.

When confronted with a new content area to be included in the curriculum, teachers often wonder where it will "fit" and how they will find time to address it. This training activity is designed to allay teachers' misgivings about STS by demonstrating that the current curriculum has many "hooks" that provide natural entrees for STS topics and themes.

The activity begins with a brief "grabber" activity that represents the least demanding way of incorporating STS issues into the curriculum. Participants then work in pairs to analyze lessons they currently teach. The activity concludes with a curriculum-mapping activity designed to more specifically identify units in each teacher's class that could be given an STS focus.

Conducting the Activity

Materials Needed: Copies of Handouts 4, 5, 6, and 7 for all participants; a few copies of Handouts 8 and 9; transparency D and overhead projector; poster paper, tape, markers; if possible, a selection of the science and/or social studies texts used in the district would be helpful (you may want to ask participants to bring the texts they are using).

Activity Objectives: Participants should be able to (1) suggest a way to use the "short takes" strategy to infuse an STS element into one of their own lessons, (2) identify at least two STS issues that could be covered in each science and/or social studies course in their curricula, and (3) identify STS issues that could be covered in the instructional units they teach.

Suggested Steps:

1. If you did the activity, "Where Is STS In My Students' Lives?", participants have already had the opportunity to identify some links between the curriculum and STS objectives. Explain that this activity will do so in more detail, making connections between specific STS topics and specific science and/or social studies courses.

2. Give each participant a copy of Handout 4. Ask participants to pair up and compare answers. For each statement where the positions differ, participants must try to convince their partners to change. Discussion is to continue until the pair is in agreement on as many items as possible. As pairs reach agreement, they should join with other pairs and repeat the discussion process with the new groups of four. Allow the doubling up and discussion to continue for about 10 minutes.

3. Call the group back together. Go through the items one at a time to gauge participants' positions. Ask individual participants to explain their reasoning for each item. How do these issues and positions reflect/affect our society? What are the "right" answers?

4. Explain that this activity is designed both to make students aware of a variety of STS issues and to serve as an introduction to more in-depth coverage of particular issues. Allow participants time to talk about how they might use such an activity (the list of issues can, of course, be revised and lengthened) in their classes.

5. Point out that brief "grabber" activities designed to heighten student awareness of STS issues are perhaps the easiest way of infusing STS into the curriculum. Explain that another approach to awareness-building is the "short takes" teaching strategy developed by Richard Brinckerhoff, a science teacher at Phillips Exeter Academy in New Hampshire. Brinckerhoff uses short items that stimulate discussion of the societal or ethical consequences of a scientific principle or law to focus attention on the effects of scientific and technological developments. "Short takes" can be challenging questions, analogies, or examples of disagreements among experts in the same field presented to students to provoke thought and brief class-opening or -ending discussions. Some examples are given in Lesson 1 in both volumes of model lessons.

Note: Some participants may point out that a "short takes" approach is inherently superficial. You should not attempt to argue with them, for such an approach does indeed give students an awareness of a potpourri of issues rather than in-depth understanding. Emphasize, however, that if a teacher is unable or unwilling to do more, this approach will at least increase awareness and perhaps motivate students to pursue issues further.

6. Explain that in gathering materials for use as "short takes" or "reaction statements" or in thinking about infusing complete lessons or units into the curriculum, it is helpful to organize information according to STS issues. Project Transparency D, explaining that it shows one list of STS issues developed by a leading science educator. While there are others as well, this list can serve as a starting point for planning. Leave the list on display as participants work through the remainder of the activity.

7. Distribute Handout 5, explaining that participants are to work in pairs, interviewing each other about ways in which STS issues could be infused into a current unit each participant is teaching. For this activity, you may allow random pairing, pair teachers of the same course, or pair science and social studies teachers at the same grade level. Allow about 15 minutes for the interviews, announcing half way through that the first interview should be completed so the second can begin. Circulate from pair to pair suggesting lesson/topic ideas from the model lesson volumes if participants are having difficulty generating ideas.

8. Depending on the size of the group, you may want to have all pairs report or you may ask for a few volunteers. Be sure that the interviewer reports on the interviewee's ideas; this allows the debriefing to proceed more rapidly. Ask participants whether they had difficulty generating ideas. Does this experience suggest that STS can be infused without great difficulty? by enriching rather than supplanting other important content?

9. Tell participants they will now do a systematic curriculum mapping activity to help plan for infusion. If you are working with a group of only social studies or science teachers, you can conduct this as a whole-group activity, with yourself acting as the facilitator/poster. If your group includes teachers of both discipline areas, the science teachers should work in a group and the social studies teachers should work in a group. If your group includes teachers from several districts, they should work in district teams.

Distribute Handout 6 and go over the directions with the group. Allow about 10 minutes for completion. In a mixed group, science and social studies teachers should share their results at the end of the work period so that each group learns about the other discipline's curriculum pattern. If your group has teachers from only one discipline and you have information on the curriculum pattern for the other discipline, share that information with the group.

10. The next step is to complete a more specific grade-level mapping. Have the group divide by grade level. If teachers teach more than one course, they should pick the one they teach the most sections of or are most personally committed to. However, you should try to have each curriculum offering represented. At first, social studies teachers and science teachers may work separately, but they should share their findings within their grade level groups. Use Handout 7 for this task, which will take 20-40 minutes to complete. Textbooks and curriculum guides used in the district would be useful at this stage in the activity. If groups are having difficulty, you may wish to give them copies of the matrices of lessons from the model lesson volumes (Handouts 8 and 9).

Note: For your convenience in answering inquiries from participants, ordering information on all the publications from the "Building Support Networks for Science/Technology/Society Education" project is provided at the end of this book.

11. When the groups have completely filled out their handouts, post and discuss the results. Three things you may wish to focus on in the discussion are: (1) places where the issues that fit well in science and social studies classes at the same grade level are the same, thus providing an opportunity for interdisciplinary cooperation, (2) cases where an issue fits into only one or two courses and therefore may need to receive greater emphasis there, and (3) cases where the same issue fits well in consecutive social studies or science classes so that cross-grade planning could provide for ever-deepening understanding of the issue as students proceed through the grades.

12. When the discussion is concluded, arrange to duplicate the complete handouts for the files of all participants.

REACTION STATEMENTS WORKSHEET

Check whether you agree or disagree with each of the following statements. Think carefully about why you feel the way you do. When you have finished, find another participant who has finished and compare answers. Discuss your answers and try to reach agreement on each of the items. Try to convince your partner of the correctness of your own position, but also listen carefully to your partner's ideas.

Agree	Disagree	
_____	_____	1. The United States should develop a supersonic transport plane (SST) to compete with the Soviets and the Europeans, whose SSTs are now in commercial use.
_____	_____	2. High school football, power mowers, and mountain climbing take more lives each year than nuclear power plants. Therefore, they should be abolished before nuclear power plants are.
_____	_____	3. The rich coal beds that underlie some of the most fertile wheat-growing land in the American west should be strip mined.
_____	_____	4. Members of Congress should be required to show that they have had (and passed) some high-school-level science courses before they take office.

INFUSION INTERVIEW

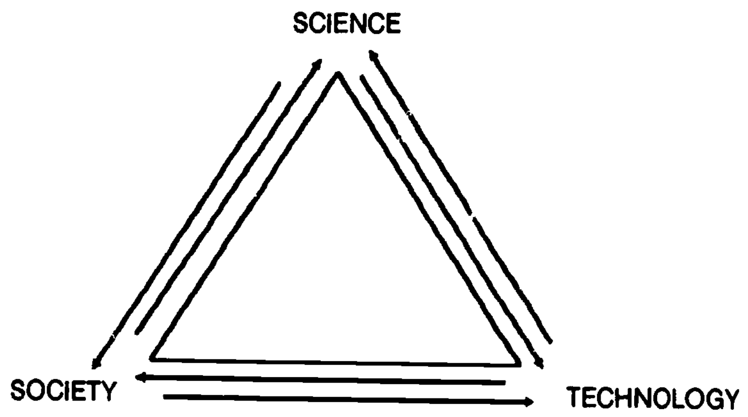
Directions: In this activity, you and a partner will interview each other about infusion opportunities in the units you are currently teaching (or a favorite unit). Take a minute to read through the questions and think about your **own** responses to them. Then begin the interviews. You will have about 15 minutes to complete the task. When you are done, you should be prepared to report on your partner's responses.

1. What is the major topic of your current unit?

2. Are any of the issues on Transparency D covered in your unit? If so, how? If not, could one be related to the content of the unit? Describe how this could be done.

3. Can you think of a provocative question, analogy, or other "short take" type of material that could be used to introduce or conclude a lesson in your unit? Please describe it.

4. Does your current unit include any lessons that draw student attention to the science-technology-society interactions? Remember, these are:



5. How might you adapt a lesson from your unit to develop student understanding of an additional interaction?

MAPPING THE CURRICULUM

Directions: In the second column below, list the course or courses in your curriculum area offered in your district or school. Then for each course, list at least two STS issues that could be infused into that course.

Science

Grade Level	Course(s) Offered	STS Issues for Infusion
7		
8		
9		
10		
11		
12		

Social Studies

Grade Level	Course(s) Offered	STS Issues for Infusion
7		
8		
9		
10		
11		
12		

PLANNING FOR INFUSION

Directions: Fill in the name of your course below. Then list the major units taught in the course. For each unit, try to generate one idea for infusing an STS issue, topic, or interaction into the unit. Work with other teachers at the same grade level.

Course: ____________________

Units (Be Specific)	STS Infusion Ideas

Units (Be Specific)	STS Infusion Ideas

MATRIX OF LESSONS IN MODEL LESSONS FOR SECONDARY SOCIAL STUDIES CLASSES

Lesson	STS Issue	World Geography	U.S. History	World History	Civics	Government	Economics	Sociology/Psychology	Current Events
1. Short Takes	Adaptable to	X	X	X	X	X	X	X	X
2. Mobiles in the Classroom	any issue	X	X	X	X	X	X	X	X
3. STS Scavenger Hunt		X	X	X	X	X	X	X	X
4. The Technology Tree		X	X	X	X	X	X	X	X
5. Knowledge, Skills, and Attitudes for the Year 2000		X	X	X	X	X	X	X	X
6. Reaction Statements Warm-Up		X	X	X	X	X	X	X	X
7. Trivialized Technology			X				X	X	X
8. Science and Technology in the News		X	X	X	X	X	X	X	X
9. STS in My Life		X	X	X	X	X	X	X	X
10. Ten Inventions That Changed Our Lives		X	X	X	X	X	X	X	X
11. Bumper Sticker Position Statements		X	X	X	X	X	X	X	X
12. World Population Growth	Population growth	X		X				X	X
13. Energy Production and Population	Population growth and energy	X		X					X

Lesson	STS Issue	World Geography	U.S. History	World History	Civics	Government	Economics	Sociology/ Psychology	Current Events
14. Fish Kill in Riverwood	Water resources				X	X	X		X
15. Solving the Problems of the World	Food resources, population growth	X							X
16. It's a Natural!	Food resources						X		X
17. Furrows to the Future	Food resources	X	X	X					
18. People and Machines	Food resources, technology and the economy	X	X				X	X	
19. Doing Something About the Weather	Air quality and atmosphere		X		X	X			X
20. Simulating the Strategic Defense Initiative	War technology		X			X			X
21. The Effects of Individual Actions on Technology and Society	War technology		X	X		X			
22. Giving Up the Gun	War technology			X					
23. Renewable Energy and the American Age of Wood	Energy shortages		X				X		
24. Energy Milestones	Energy shortages		X				X		
25. Preparing Environmental Impact Statements	Land use	X			X		X		
26. The Freeway Planning Game	Land use	X			X	X	X		

Lesson	STS Issue	Geog-raphy	U.S History	World History	Civics	Govern-ment	Eco-nomics	Sociology/ Psychology	Current Events
27. The Organ Hunter	Human health and disease					X			X
28. Warning Future Generations	Hazardous substances, nuclear reactors	X				X			X
29. The Environment and Participatory Democracy	Environmental protection				X	X			X
30. A Resource-Use Warm-Up	Mineral resources	X	X				X		
31. The Ocean Resources Game	Mineral resources	X				X			X
32. God and the Alarm Clock	Technology and change			X					
33. A Social History Approach: Machine and Social Change in Industrial America	Technology and change		X				X	X	
34. Technology and Transportation	Technology and change		X			X	X		
35. Science, Technology, and the Constitution	Government		X		X	X			
36. The Structure of Scientific Revolutions	Scientific inquiry		X	X				X	

MATRIX OF LESSONS IN MODEL LESSONS FOR SECONDARY SCIENCE CLASSES

Lesson	STS Issue	Life Science	Earth Science	Physical Science	General Science	Biology	Ecology	Environmental Studies	Chemistry	Physics
1. Short Takes	Adaptable to	X	X	X	X	X	X	X	X	X
2. Technology Mind Walk	any issue	X	X	X	X	X	X	X	X	X
3. Technology Timeline		X	X	X	X	X	X	X	X	X
4. The Futures Wheel		X	X	X	X	X	X	X	X	X
5. Global and Local Issues		X	X	X	X	X	X	X	X	X
6 Determining Priorities		X	X	X	X	X	X	X	X	X
7. Technology and Advertising		X	X	X	X	X	X	X	X	X
8. Science and Technology in the News		X	X	X	X	X	X	X	X	X
9. STS in My Life		X	X	X	X	X	X	X	X	X
10. Ten Inventions That Changed Our Lives		X	X	X	X	X	X	X	X	X
11. Bumper Sticker Position Statements		X	X	X	X	X	X	X	X	X
12. Population Control: Where Do You Stand?	Population growth					X			X	
13. Groundwater Rights	Water resources		X		X	X	X		X	
14. Food Additives	Food resources					X			X	X

Lesson	STS Issue	Life Science	Earth Science	Physical Science	General Science	Biology	Ecology	Environ-mental Studies	Chemistry	Physics
15. Environmental Impact Statements	Air quality and atmosphere					X	X	X		
16. What Would You Do If...?	Air quality, energy	X		X	X	X	X	X		
17. Collecting Points of (pH)iew	Air quality	X	X	X		X	X	X		
18. The Biological Effects of a Nuclear Explosion	War technology				X	X			X	X
19. Energy Sources	Energy shortages			X	X			X		X
20. Energy Sources in the Good Old Days	Energy shortages			X	X			X	X	X
21. Life Without Petroleum	Energy shortages	X	X	X	X	X	X	X	X	X
22. Land Use	Land use	X	X		X	X		X		
23. The Artificial Heart: A Technological Alternative	Human health and disease control				X	X				
24. The Benefits of Technology: Conquering Disease	Human health and disease control					X			X	
25. Genetic Screening	Human health and disease control				X	X				
26. The Pine Beetle Controversy	Hazardous substances				X	X		X	X	
27. Pesticides: A Global Problem	Hazardous substances					X		X	X	

Lesson	STS Issue	Life Science	Earth Science	Physical Science	General Science	Biology	Ecology	Environmental Studies	Chemistry	Physics
28. Biodegradable and Nonbiodegradable	Hazardous substances	X	X	X	X	X	X	X		
29. Letters to the City Council	Hazardous substances	X	X	X	X	X	X	X	X	X
30. Ecology and the Government	Extinction of plants and animals		X		X	X	X	X		
31. Forest Products All Around Us	Extinction of plants and animals	X				X		X		
32. Nuclear Energy: Risks Involved in a New Technology	Nuclear reactors							X	X	X
33. Can We Continue to Use Things Up?	Mineral resources						X	X	X	X
34. Soil Deterioration	Mineral resources		X		X	X	X	X		
35. Scientific Experimentation with Animals	Ethics				X	X			X	

HOW CAN WE SELECT GOOD STS MATERIALS?

Background Notes

Evaluation of curriculum materials should take place after teachers and other concerned professionals and community members have established a clear rationale for the inclusion of STS in the school program. This being done, goals for the program should also be delineated and clarified, and the process of selecting curricula can begin.

Many factors must be considered in choosing curriculum materials. These include relationships to the program objectives and rationale, potential student interest, age appropriateness, opportunities for teacher requirements, bias, and cost. As teachers and district coordinators begin to consider materials, they will doubtless find some that meet many, but often not all, of these criteria. Decisions will ultimately have to be made taking this into account.

The selection committee should include teachers, social studies and science coordinators, administrators, and interested community members (including parents). A representative, though not unwieldly, group should be formed. Each of the group members should be instructed in the materials analysis system and be familiar with the course or district rationale for education about STS. A workshop of two to three hours will be needed to teach the use of the system; considerable analysis time will be required after that.

Conducting the Activity

Materials Needed: Posting paper, marking pens, masking tape, blank analysis forms (Handout 10), and sample curriculum materials.

Activity Objective: Participants should be able to (1) determine district or school criteria for selecting STS materials, (2) identify available materials that meet district criteria, and (3) analyze materials using specific agreed-upon criteria.

Suggested Steps:

1. Explain the purpose of the workshop and begin by asking participants to brainstorm, in small groups, all the criteria they believe are important in selecting curriculum materials for use in an STS program. Ideas might include:

- Content having immediate utility for students
- Opportunities for higher level thinking
- Student activity focus
- Emphasis on inquiry methods
- Variety of instructional methods
- Opportunities for interdisciplinary study
- Valuing activities at each grade level
- Age appropriateness
- Creative thinking and problem-solving activities

The list should reflect program goals and rationale, as well as teacher, school, community, and student needs. These items provide the overall criteria with which to examine curriculum materials.

2. Give each small group a piece or two of curriculum to examine. From this cursory examination, each group should list from three to five of the most distinctive characteristics of its sample materials. Post the lists when groups have finished and discuss commonalities and differences that are evident in the lists. Can logical categories of characteristics be generated?

3. Distribute copies of the STS Materials Analysis Form (Handout 10) and review it with the participants. Explain that the information about sample materials will be recorded on this form, and that the forms will be used later as the basis for making decisions regarding selection and adoption of materials. Point out that the forms include criteria related to general soundness of the materials, as well as criteria related specifically to STS content, skills, and attitudes. If you wish to focus primarily on the STS criteria, analysts may look only at questions 3 and 4.

4. Ask small groups to spend 20-30 minutes using the form with a sample piece of curriculum. Assemble all of the participants and discuss any problems that arose. Note the importance of responding to the final questions that summarize the work of the analyst.

5. Several guidelines for making best use of this curriculum materials analysis system are:

- Any piece of curriculum should be analyzed by at least two persons—preferably three—working separately.
- Any supplemental materials (such as student workbooks, readings, or handouts) should be analyzed.
- Analysis forms should be kept for future reference and as documentation that a structured process for curriculum selection was undertaken.
- Local issues and concerns should be kept in mind as materials are evaluated and discussed.

6. After members of the committee are instructed in the process of using the curriculum materials analysis system, they should begin to look at sample curriculum materials. At this stage, few value judgments regarding the materials should be made. The task is to see whether or not certain elements are included in the materials. The debate over what elements should be included either has already taken place in the formation of the rationale and objectives or will take place at the time when actual selections are to be made.

It is worth mentioning that the form to be used is designed for print materials, but can work well with nonprint items as well. It can also be used to evaluate individual lessons being considered by a teacher.

One final caution involves the numerous STS materials available from private corporations. Some of these materials are exemplary while others are quite biased. Consequently, reviewers should be advised that especially careful analysis of such materials is in order.

7. When all analyses are completed, final selection can take place either by an individual or, on the basis of the analyses, by the committee.

Notes:

1. The form presented here is an adaptation of one presented in James E. Davis, editor, *Planning a Social Studies Program: Activities, Guidelines, and Resources* (Boulder, CO: Social Science Education Consortium, 1983); a longer version of the unadapted form is available in that resource. The short form was adapted to reflect the criteria for STS developed by Faith M. Hickman, John J. Patrick, and Rodger W. Bybee, in *Science/Technology/Society: A Framework for Curriculum Reform in Secondary School Science and Social Studies* (Boulder, CO: Social Science Education Consortium, 1987).

STS MATERIALS ANALYSIS FORM

This analysis system was designed to assist those involved in assessing materials appropriate for the district STS program. Ratings on the criteria listed are as follows: 1-Does not meet criterion; 2-Partially meets criterion; 3-Mostly meets criterion; 4-Fully meets criterion; N/A-Criterion not applicable for grade level.

Name of Analyst ______________________________

Materials Title ______________________________

Publisher ______________________________

Copyright Date ______________________________

Grade Level (according to publisher) ______________________________

1. Readability of Student Materials

   a. Publisher's assessment ______________________________

   b. Analyst's assessment (see Attachment A)

   ☐ Appropriate for intended grade level ☐ Too difficult ☐ Not challenging enough

	1	2	3	4	N/A
2. Format of Materials					
a. Are the materials attractive to students?					
b. Are the materials (i.e., bindings, paper covers) durable?					
c. Is the print clear and easy to read?					
d. Are the photographs and other illustrations attractive and well-produced?					
e. Are the illustrations germane to the text?					
f. Are instructional aids (advance organizers, review questions. extending activities) built into the student materials?					
g. Does the material include essential end-of-book aids (bibliography, index, glossary)?					
3. Rationale and Objectives					
a Does the material's rationale match the district rationale?					
b. Do the material's knowledge objectives match district knowledge objectives?					

	1	2	3	4	N/A
c. Do the material's skill objectives match district skill objectives?					
d. Do the material's attitude objectives match district attitude objectives?					
4. Content					
a. Knowledge					
(1) Is the topic one for which students show interest and enthusiasm?					
(2) Is the topic directly applicable to the lives of learners now?					
(3) Is the topic important in the world today and is it likely to remain important for a significant portion of students' adult lifetimes?					
(4) Does the material emphasize knowledge of major concepts in science and technology?					
(5) Does the material emphasize knowledge of major concepts in history and the social sciences?					
(6) Does the material treat interrelationships of science and technology in a social context?					
(7) Does the material emphasize uses, limits, possibilities, and variable social consequences of scientific and technological endeavors in the past and present, nationally and globally?					
(8) Does the material examine past and present public issues, in national and global perspectives, associated with human effects of science and technology?					
b. Skills					
(1) Does the material emphasize development of cognitive process skills involved in scientific/technological inquiry (e.g., asking researchable questions, formulating hypotheses, designing and carrying out experiments, observing, measuring, inferring)?					
(2) Does the material emphasize development of cognitive process skills involved in civic decision making (e.g., identifying a problem, identifying alternative courses of action, identifying costs and benefits of various alternatives, choosing a course of action)?					

	1	2	3	4	N/A
c. Attitudes					
(1) Does the material foster appreciation of science and technology as worthwhile human endeavors?					
(2) Does the material develop understanding of an intelligent commitment to values, attitudes, and assumptions associated with products, processes, and persons of science--the knowledge produced by scientists, the methods used by scientists, and the individuals engaged in scientific inquiry?					
(3) Does the material develop understanding of an intelligent commitment to values, attitudes, and assumptions of a democratic or free society?					
(4) Does the material emphasize the critical importance of ethical questions about the limits and possibilities of science/technology in society?					
(5) Does the material develop commitment to rational consideration of issues related to applications of science and technology in society?					
(6) Does the material teach values and attitudes of science and democracy in combination with knowledge and cognitive process skills that are central to studies of science/technolgy/society?					
d. Are the materials free of bias (religious, sex, political, ethnic)?					
5. Instructional Characteristics					
a. Do the materials provide for a variety of learning activities?					
b. Do the activities take into account students' cognitive development and social maturity?					
c. Are primary source materials and field experiences employed?					
d. Do the materials use direct or didactic teaching as a means to introduce skills?					
e. Do the materials provide continual practice to direct students' use of cognitive process skills, to correct mistakes immediately and constructively, to reinforce desirable performance, and to enhance learning?					
f. Do the materials emphasize practice of skills with recognition of how they are part of a larger process?					

	1	2	3	4	N/A
g. Do the materials provide opportunities for transferring skills to new contexts?					
h. Do the materials guide and stimulate students to think about resolution of problems and take stands on issues?					
6. Teacher Materials					
a. Are the materials easy to use?					
b. Is preparation time reasonable?					
c. Are the materials well organized?					
d. Are the materials complete?					
e. Are evaluation procedures or tools provided?					
f. Do the materials provide obvious entry points to core science/social studies courses? (If being infused)					

7. Distinguishing Characteristics

8. Overall Evaluative Comments

HOW CAN WE DEVELOP GOOD STS LESSONS OR UNITS?

Background Notes

Many teachers may find it difficult to locate materials on the particular STS issues or concepts they have decided to teach. Others may not be ready to invest any of their materials budget in STS materials—or may have no budget for such purchases. Thus, the ability to locate usable material in the popular media and develop lessons around that material will be a necessary skill in fitting STS into the curriculum. This activity aims to help participants begin developing that skill.

The activity opens with a search through magazines and newspapers for STS items, which participants then analyze as to their content and relationship to the curriculum. Then participants use a worksheet to outline lessons based on the material.

Two supplements to the activity can be used at the facilitator's discretion. Because a vertical file on STS issues can be a great aid to teachers, we include (as Handout 15) an activity that involves students in the development of such a file. Second, because achieving the varied goals of STS education requires the use of a variety of teaching strategies that motivate and involve students, we have included guidelines on various teaching strategies in Appendix B. These may be distributed to participants as take-home materials, be discussed as a large- or small-group activity, or be available as resources in the lesson development portion of the training activity. Although some teachers may be conversant with all these strategies, others may need encouragement to incorporate them into STS lesson plans. The trainer can determine whether use of the Appendix B materials is appropriate based on his/her knowledge of the audience.

Conducting the Activity

Materials Needed: Copies of Handouts 11, 12, 13, and 14; Transparencies A, D, E, F, and G; overhead projector; posting paper, markers, tape; collection of current newsmagazines, newspapers, and textbooks; copies of Handout 15 and materials from Appendix B (optional).

Activity Objectives: Participants should be able to (1) identify material covering STS topics in the popular media, (2) evaluate the appropriateness of the content presented in such materials, and (3) develop a lesson plan around identified materials.

Suggested Steps:

1. Discuss briefly the fact that teachers may not be able to find or afford published curriculum materials on the STS concepts and issues they want to cover in their courses. Thus, the ability to develop lessons based on other materials will be important. Luckily, such materials are easy to find in the popular media.

2. Distribute copies of Handout 11 and magazines or newspapers to each pair of participants. Have pairs go through the magazines or newspapers until they locate an item that covers STS content. They should analyze the content of the item using the questions on the handout. You may want to have Transparencies A, D, and E and an overhead projector available so that participants can review the concepts, issues, and interactions discussed in earlier activities. Allow about 20 minutes for completion of this task.

3. Ask the pairs what topics they found. Post the topics. What trends do they see? How difficult was it to find topics? What important issues were not covered? What kinds of sources might have information on these issues? This is an appropriate time to point out the utility of developing a vertical file on

STS issues; working with the building media specialist is recommended to prevent duplication of teachers' efforts. If you wish, you may distribute Handout 15, which provides directions for a lesson in which students help develop the vertical file.

4. Then ask each pair to report briefly to the group on the analysis of their item—describing the interaction that is stressed and any concepts that could be developed using the item and identifying where in the curriculum the item might fit. Allow time for brainstorming of additional connections between the items found and existing courses. Post these lists as well.

5. Distribute copies of Handout 12 and go over the lesson-development process it presents step by step. In discussing the development of knowledge, skill, and attitude objectives, go over the list of STS skills (Transparency F) and the guidelines for education on values and attitudes in STS (Transparency G). Participants might also find the list of action verbs for instructional objectives (Handout 12) helpful.

In discussing selection of strategies, urge teachers to vary from the traditional reading/lecture/discussion mode. You may want to post the list of strategies covered in Appendix B on a posting sheet and ask teachers to choose from this list in developing their lessons; you might even assign a particular strategy to each participant pair. Depending on the group with which you are working and the time available, you may wish to go over some of the material presented in Appendix B or make copies of the material available to pairs as they work.

Stress the importance of planning how a lesson will be debriefed—how students will be helped to draw out the major ideas from the lesson and make connections between those ideas and what they have learned previously. The list of questions on Handout 14 is provided not as a prescriptive list, but as a starting point for generating debriefing questions. It can be distributed to participants at this time if you wish. Note that none of the questions on the list can be answered with a one-word response. All require thought and have more than one correct response.

While teachers need not spend a great deal of time on evaluation in this activity (evaluation is treated more fully in Chapter 6), thinking about possible ways of evaluating an activity provides a check on whether the objectives are specific enough.

6. When you have gone over the handout and answered any questions, have the pairs work together again, planning a lesson on the item they analyzed in Handout 11. Allow about 30 minutes for the pairs to work on their lesson plans.

7. Bring the group to order. Ask each pair to identify the skills and attitudes they targeted, as well as the teaching strategy they decided to use. What kinds of debriefing questions did they develop? Allow considerable time for sharing before discussing how well the process worked for participants and soliciting any suggestions for adapting the process.

8. Conclude the activity by asking participants to brainstorm how they can share information from this activity with other members of their district, school, or department and how teachers might cooperate with librarians/media specialists in building STS vertical files for teacher use in lesson development and student use in conducting research. Post the responses.

ANALYZING STS INFORMATION FROM THE ...EDIA

Directions: Work with a partner. Look through magazines and newspapers until you find an item that covers an STS topic or issue. Read the item and answer the following questions about it.

1. What STS issue or topic does this item cover? ____________________

2. Are all three elements of STS—science, technology, and society—embodied in this item? __________

3. Which STS interaction is stressed? ____________________

4. What STS concepts could be developed using this item? ____________________

____

5. Is the content directly applicable to the lives of the learners both now and in the future? __________

6. Is the topic important in the world today and is it likely to remain important for a significant portion of the students' adult lifetimes?

____

7. Is the topic one in which students show an interest? ____________________

8. In what courses would this topic fit? ____________________

____

9. Is the topic appropriate for the maturity level and cognitive development of students in those courses?

____

10. Based on this analysis, is the item appropriate for use as the centerpiece of an STS lesson?

____

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DEVELOPING AN STS LESSON

Directions: Using the item you analyzed in Handout 11 (or another item if your analysis indicated that the original item would not be appropriate material for an STS lesson), develop a lesson by following the steps given below.

Writing Objectives

Think about the purpose of the lesson. What knowledge do you want students to gain? What skills will you introduce or reinforce? What values and attitudes will you target? It may be helpful to remember that knowledge, skills, and attitudes can be categorized as follows:

Knowledge	Skills	Values/Attitudes
Interactions	Processing Information	About Knowledge
Concepts	Solving Problems	About Persons Engaged in Scientific Inquiry
Issues	Making Decisions	About Citizenship in a Free Society

Write at least three objectives for your lesson. Write your objectives so that you will be able to measure whether the desired outcomes have been achieved:

Developing the Instructional Strategy

In planning what instructional strategy to use, you will need to think about several factors: how to engage student interest, how to develop the topic or concept at the heart of the lesson, how to provide for skill practice, and how to debrief the lesson so that students are able to draw out the major ideas and make connections between those ideas and their previous learning. How will you introduce the lesson? Describe how you will engage student interest in the material.

What teaching strategy will you use to convey the lesson's main idea? Briefly outline how you would teach the lesson; be sure to provide for skill development/reinforcement.

List three to five questions that could be used in debriefing the lesson.

Evaluating the Lesson

Briefly describe how you would evaluate student achievement of the instructional objectives.

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ACTION VERBS FOR INSTRUCTIONAL OBJECTIVES

KNOWLEDGE: cites, defines, describes, identifies, lists, matches, names, points out, recalls, recognizes, relates, remembers, repeats, rephrases, reports, states, tells, writes

COGNITIVE PROCESSES:

Questioning and Searching: asks, discovers, locates, questions, researches

Observing and Organizing: identifies, observes, orders, sequences

Measuring and Classifying: arranges, associates, catalogs, categorizes, counts, distinguishes, groups, labels, orders, organizes, outlines, places, quantifies, rearranges, reorders, sorts, structures

Analyzing and Synthesizing: analyzes, assembles, breaks down, composes, constructs, combines, creates, depicts, derives, designs, detects, develops, devises, differentiates, divides, examines, experiments, expresses, extracts, formulates, identifies, illustrates, inspects, integrates, inventories, lists, makes, organizes, outlines, points out, prepares, plans, produces, puts together, proposes, questions, relates, separates, synthesizes

Identifying and Describing: describes, gathers, recognizes, researches

Hypothesizing and Predicting: deduces, develops, derives, draws, extends, extrapolates, formulates, generates, presents, proposes

Separating and Controlling: compares, contrasts, distinguishes, identifies

Exploring and Evaluating: appraises, argues, assesses, chooses, criticizes, decides, describes, evaluates, explains, grades, judges, justifies, measures, ranks, rates, rejects, scores, states worth of, validates, weighs

Deciding and Acting: enacts, identifies, justifies, selects

ATTITUDES: advocates, acclaims, approves, believes in, chooses, defends, demonstrates, opposes, praises, prefers, reacts positively or negatively toward, recommends, rejects, selects, supports

STS QUESTIONS

This short list of questions can be used to help stimulate thinking about developments in science, technology, and society. The questions can be used or adapted for use in debriefing many STS lessons.

For each story, invention, event or process under consideration, ask the following questions:

1. What are some likely short-term effects on science, technology, and society?
2. What are some likely long-term effects on STS?
3. What similarities are there to events that occurred in the past?
4. Who are the *specific* actors in this development?
5. What are the religious, moral or ethical implications?
6. What are the military implications?
7. What are the political implications?
8. What are the economic implications?
9. How important is physical location to the development? (Could this only happen in one specific place?)
10. What is the scope of the development? (How widely will the effects be felt—locally, nationally, or globally?)
11. What is the likelihood of any risks from this development?
12. What is the potential magnitude of such a risk?
13. What power or control do local/state/national leaders have over this development and concurrent risks?
14. What power or control do citizens have over this development and concurrent risks?
15. What are the benefits of this development?
16. What are the drawbacks of the development?

ENVIRONMENTAL SCANNING

Introduction:

A vertical file of materials on STS trends, topics, and issues can be an invaluable tool in developing STS lessons. This activity describes how students can be involved in developing the vertical file as they learn about a popular form of futures forecasting—the extrapolation of past-to-present trends into the future. This technique is called trend extrapolation or trend forecasting. If, for example, population growth in a small city in the United States has been at the 2-percent level for the past 40 years, one might extrapolate or (extend) this trend into the future, say for the next 15 years. This mode of forecasting assumes continuity (as opposed to change) from the past to the present and into the future. It assumes a trend or pattern will remain constant with little variation. It further assumes that dramatic shifts and "revolutions" are uncommon and relatively unpredictable.

One way to do trend forecasting is by use of the technique of environmental scanning. This involves selective scanning of the voluminous popular literature: newspapers (e.g., *Wall Street Journal*, *New York Times*, *Washington Post*, and local papers), newsmagazines (e.g., *Time*, *Newsweek*), best-selling non-fiction (e.g., *Megatrends*), general interest magazines (e.g., *Omni*, *Money*, *Atlantic*), radio programs (e.g., National Public Radio), television programs (e.g., "Nova" series on PBS), and other similar sources. With a little practice, one quickly picks up the skill of "scanning," of picking out items that describe present trends on crucial topics. Most items can be summarized in 50 words or less (look for totals and percents), and then can be keyed to one of several topic categories. Students will have an opportunity to practice using the scanning techniques in this lesson.

Objectives: Students will be able to:

1. Selectively scan the news of the day.
2. Select, clip, and file possible trend items.
3. Use a category system for keying items.
4. Become interested in and pursue a category.
5. Describe trends within a single category.

Grade Level: 9-12

Teaching Time: 3 class periods

Materials: Copies of trend categories for all students; copies of enough 3" x 5" cards for each student to have 10-20 cards; enough copies of recent newspapers and magazines for all students to select and clip trend items (students might be asked a week or two in advance of this lesson to bring in newspapers and magazines that families no longer need or use; be sure to provide storage places for these); sample trend cards prepared by the teacher; 12 file folders for clipped items.

Adapted from *Teaching About the Future: Tools, Topics, and Issues*, by John D. Haas and others (Boulder, CO: Social Science Education Consortium, 1987.)

Procedure:

1. Explain to the students the technique of trend forecasting; describe environmental scanning as one form of this type of forecasting. Illustrate trend forecasting by having students draw on past-to-present trends they have experienced already in their lives. For example, every year students have been in school, they have 180+ days; thus, unless they are seniors, next school year will also be 180+ days. Other examples for students to consider are the fact that the size of an elementary school's first grade next year depends on that school's kindergarten class this year, plus new residents and minus families that move; and the life cycle in families of birth, growth, and death as represented by grandparents, parents, and children.

2. As a tool both to guide the scanning process and to aid in keying and filing items, a category system is useful. Below is an example for twelve STS issues, though many other categories could be added. Explain the three-letter codes, the categories, and the examples. Encourage students to familiarize themselves with the system by asking for their "opinion forecasts" (based only on experience, hunches, and intuition) of trends for four or five examples drawn from several categories.

Trend Categories

Codes	Categories	Examples
POP	Population growth	World population Immigration Carrying capacity
WAT	Water Resources	Waste disposal Estuaries Supply Distribution Ground water contamination
HUN	World Hunger and Food Resources	Food production Cropland conservation Crop yields Diet Drought Fertilizers Malnutrition
AIR	Air Quality and Atmosphere	Acid rain CO_2 Depletion of ozone Global warming
WAR	War Technology	Nerve gas Nuclear developments Disarmament T[illegible]ism

Codes	Categories	Examples
ENE	Energy Shortages	Synthetic fuels Solar power Fossil fuels Conservation Oil production Geothermal power
LAN	Land Use	Soil erosion Reclamation Urban Development Wildlife habitat loss Deforestation Desertification
HHD	Human Health and Disease	Infectious and noninfectious diseases Stress Noise Diet and nutrition Exercise Mental health Addictions Pharmacology
HAZ	Hazardous Substances	Waste dumps Toxic chemicals Lead paints
EXT	Extinction of Plants and Animals	Reducing genetic diversity Wildlife protection
NUC	Nuclear Reactors	Waste management Breeder reactors Cost of construction Safety Terrorism
MIN	Mineral Resources	Nonfuel minerals Mining and the environment Low-grade deposits Recycling/reuse

3. Before turning the class loose on the newspapers and magazines (they can also draw from radio and television, at home and/or at school), show them how you did a few sample cards (four or five) and where you found the items you summarized. Here you can point out the ways to summarize an article in 50 words or less: by focusing only on the trend(s), by being cryptic in use of words, and by using numbers or percents. Be sure you read the symbol of the category you assigned each card to; emphasize that the symbol should be placed in a consistent place on every card.

4. Next, make sure each student has ten or more 3" x 5" cards and at least two sources (i.e., newspapers and magazines). Have them search for just two trends; summarize each one on a card;

and then key each card to a category by use of one of the three-letter symbols. Give students about 30 minutes to do this. Then ask each student to read to the class one card (i.e., summary of trend and symbol for category).

5. Now students should be ready to continue scanning, searching out and clipping items, summarizing items on cards, and keying the cards and clipped items to categories. Give them an hour for this (in class, as homework, or as a combination of the two), and encourage them to do at least ten cards, but to do more if they want.

6. When each student has ten cards ready, there will be approximately 250-300 cards and clipped items among all students in the class. On the chalkboard, record the number of cards prepared for each of the 14 categories. For the category with the most cards, have students read their trends to the class. Do a few more categories (maybe the second- and third-place categories from your chalkboard tally) if you want and have the time.

Follow-up:

If you wish to extend the lesson into a project for a few weeks, a quarter, or for the rest of the semester, have each student (the entire class or only those so inclined) specialize in just one or two categories. The end result of such a project might be one of the following: (1) a collection of 40-50 cards and clipped items in a single category, (2) a compilation of 40-50 cards in a summary essay, (3) a collection plus a scrapbook, (4) an essay plus a scrapbook, or (5) a short story (or other creative product) based on the cards in a category.

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5. IMPLEMENTING STS

General training objectives addressed by the activities in this chapter include:

- To help participants identify goals and objectives for an STS course.
- To engage participants in the initial steps in content selection.
- To demonstrate in a nonthreatening way the potential for interdisciplinary planning and teaching.
- To help participants develop an implementation/action plan for STS.

HOW CAN THE SCIENCE AND SOCIAL STUDIES DEPARTMENTS WORK TOGETHER?

Background Notes

Many proponents of STS education have argued for development of interdisciplinary courses that go beyond the bounds of only science or only social studies. The development of such a course, however, demands a high level of commitment as well as adequate resources and support from the administration and teachers in both departments. While teachers should be exposed to the idea of an interdisciplinary course, to suggest that such a course is *the* way for science and social studies teachers to cooperate can be intimidating and limiting.

This activity is designed to help participants think about a range of ways in which science and social studies can cooperate in providing STS education. Participants begin by reading an STS lesson from the *Model Lessons for Secondary Science Classes* and suggesting the courses in which the class would be used; science and social studies teachers compare the ways in which they would present the activity. The activity is used to stress that the two teachers can do the same lesson but bring different perspectives to it. Participants then place themselves on a continuum from complete lack of cooperation to total cooperation and identify some of the intermediate points along the continuum. Participants get together in grade-level groups to discuss first steps that could be taken in moving along the continuum. To conclude the activity, participants read and discuss three case studies of interdisciplinary courses.

It would be helpful for the trainer to know, in advance, what constraints may be placed on cooperation in participants' district or school. Knowing whose approval is needed to implement cooperative plans will aid in developing action plans.

Conducting the Activity

Materials Needs: Copies of Handouts 16 and 17 for all participants; enough copies of Handouts 18, 19, and 20 for one-third of the participants; posting paper, markers, tape

Activity Objectives: Participants should be able to (1) describe how a science teacher and social studies teacher could enrich an STS lesson by providing different perspectives, (2) suggest ways to further cooperation between the science and social studies departments, and (3) list first steps in exploring how an interdisciplinary course might be developed.

Suggested Steps:

1. Point out that while individual teachers can do a great deal to infuse STS into their courses, cooperative efforts between social studies and science teachers can be even more effective. In this activity, participants will begin exploring some avenues for cooperation.

2. Pass out copies of Handout 16, a lesson on garbage disposal and decision making. Point out that the **Subject/Grade Level** designation is left blank. Ask participants to read the activity, determine in what courses they think it could be used, and think about what aspects of the lesson they would stress if they used it in their classrooms. Allow about 10 minutes for this task.

3. Ask participants to call out all the classes they felt the course could be used in. Post the responses. You may wish to point out that the original author of the activity suggested that it could be used in civics, government, and any secondary science course; it also supports language arts through the writing exercise!

4. Next, discuss how participants would present the lesson—what aspects would they stress? Post their responses, looking for differences between the science and social studies teachers. Would the different emphases of the two disciplines enrich the learning for students?

5. Ask participants to suggest how a science and social studies teacher might cooperate in presenting this lesson. Explain that there are many forms of cooperation, which can be placed along a continuum from total isolation to total cooperation. Designate one wall of the room to represent the continuum; ask several volunteers to place themselves along the continuum according to their current level of cooperation. Ask each to explain his/her reasons for the choice; if their responses include any examples of cooperation, post these.

6. Ask participants to suggest other ways of cooperating that would fall between the two ends of the continuum. These might include sharing of notes between science and social studies teachers to look for connections; setting objectives to take advantage of the connections and to highlight bridges; joint planning of concurrent, mutually supportive units; joint planning of an integrated unit; team teaching of an integrated unit; team teaching of an integrated course.

7. Divide the group into smaller, grade-level groups, giving each group a copy of Handout 17 for use in developing a work plan for improving cooperation between the departments. Encourage groups to be realistic—it is better to begin with a limited plan that can be achieved than a far-reaching plan that is destined for failure. Allow about 15 minutes for this task and then have groups share their plans.

8. Tell participants that they are going to read some case studies of cooperation between science and social studies teachers. Form groups of three, giving each member of a triad a different handout—18, 19, or 20. Each person is to read the case study he/she has been given and report on it to the other two members of the group. The groups should then discuss the case studies, developing at least one suggestion they can adapt or use and one caution they should keep in mind as they proceed with their cooperative efforts. Allow 20-25 minutes for the group work.

9. Reconvene the groups and ask them to share the ideas they are going to use and the cautions they are going to heed. Post these for further thought and discussion.

LETTERS TO THE CITY COUNCIL

Introduction:

If all the garbage in the United States was collected and put into garbage trucks that were parked bumper to bumper, the line of garbage trucks would stretch from California to Florida. This analogy suggests that the United States has a garbage problem. In some states, the problem is a monumental one. Most of the states in the northeastern United States have run out of land on which garbage can be disposed. These states are turning to such alternatives as incineration and mandatory recycling programs.

In this lesson, students read about a hypothetical community that must decide what to do about its garbage problem. Students review information provided by various sources, work in a group to discuss the alternatives, and write individual reports to the city council regarding the decision to be made.

Objective: Students will be able to:

1. Explain why the United States has a garbage problem and where that problem is most severe.

2. Describe risks involved with the various disposal technologies.

3. Analyze a case study and propose a solution to the problem presented in the case study.

4. Value the ability of each individual to help solve the garbage problem.

5. Value the process by which consensus is reached.

Subject/Grade Level:

Time Required: 1-2 class periods

Materials and Preparation: Make copies of the student handout for all students. Make a set of Consultant Cards for each group of five students.

Procedures:

1. Introduce the garbage problem using the analogy provided in the **Introduction**.

2. Distribute copies of the student handout. Have students read this information individually. Review the information provided with the class.

3. Go over the steps involved in making a decision. List these on the chalkboard:

- Identify the issue.
- Determine alternative solutions for the issue.
- Weigh the costs and benefits of each alternative solution.
- Determine the most appropriate solution for the issue.

Discuss each step with the students.

4. Divide the class into groups of five students. Give each group a set of Consultant Cards. Have students read and discuss the cards in their groups. They should then begin the decision-making process. Each group should appoint one person to take notes as the decision-making process is implemented. This person will report back to the entire class. Allow groups time to determine a proposed plan of action for this situation.

5. When all groups have completed their decision-making process, ask each group to report back to the class. The group reporters should report the following:

- What was the issue identified?
- What were the alternatives?
- What were the costs and benefits of each alternative?
- What was the final solution adopted by the group?
- Why was this alternative adopted?

6. After each group has reported, ask the entire class the following questions:

- What is the value of using this type of decision-making process to help solve a problem?
- What could individuals do to help solve a local garbage problem?
- Who should be responsible for deciding what kind of garbage disposal facility a community uses?
- How important should individual opinions be in a community decision?
- How can individuals become more involved in local, state, and national decision making?

7. Conclude the lesson by asking each student to prepare a written report, addressed to the Greenville City Council, that will help the city council make its decision about the kind of garbage disposal facility to build.

Evaluation:

Key to this activity is the students' understanding of the decision-making process. You will need to circulate around the groups, listening to the discussions to determine if all students are participating in the process. The written report prepared by each student should give evidence of the process that was conducted by each group, as well as students' understanding of the garbage issue.

Extension/Enrichment:

1. Have students visit a city council or county commissioners meeting to learn more about how local decisions are made. Or invite the mayor, city manager, council member, or commissioner to address the class, discussing the individual's input into the decision-making process of a community.

2. Identify local issues through the newspaper or electronic media. Have students research these issues, discuss the alternatives that could be suggested, and come up with a proposed solution. Encourage students to write letters to the local newspaper expressing opinions about the issue studied

Resources:

"Buried in Garbage," *Washington Times* (January 17, 1986), pp. 6-17.

Diamond, Stuart, "Garbage—Our Wasted Resource," *Newsday's Magazine* (May 6, 1979), pp. 18+.

Hornig, Roberta, and James Welsh, "Garbage Piles Up, And Up, And Up," *The Washington Star* (1970).

Johnson, David P., "Trash Tells a Tale," *The National Observer* (December 20, 1975), pp. 1-14.

Marcus, Steven J., "The Cost of Waste," *New England/Boston Sunday Globe* (May 23, 1976), pp. 11-12+.

Shavitz, Burt, "Fighting to Save the Earth From Man," *Time* (1970).

GREENVILLE'S GARBAGE

Greenville, a city of 63,000 people, is faced with a technology dilemma. Because of the amount of garbage produced in the city, the landfill will be full within two years. After extensive research, city officials have determined that two solutions to the problem must be considered. Either the city will build another landfill next to the current landfill, or it will build an incinerator where the city's garbage can be burned.

These two options have been carefully considered by the city council. Experts have presented information for the city council to consider. Input from residents of Greenville will also be important for the city council to consider prior to making its decision. After all the citizen input has been considered, the city council will make its decision.

You are a member of a citizen's group that will send a recommendation to the council. In your group, review the information provided by the five special consultants. With your group, decide what action to recommend to the city council.

Carol Johnson, Hydrologist

As a hydrologist, I evaluate the levels of pollutants found in our groundwater. Since Greenville relies on groundwater for its drinking water, our water supply must remain uncontaminated. If a new landfill is built at the proposed site, there is a 35 percent chance that contamination will occur. Although the Envionmental Protection Agency requires that all new landfills be lined with special plastic materials and that regular testing be done for leaching of hazardous chemicals into the soil and eventually the groundwater, strong evidence shows that even the best-built landfill will eventually leak, contaminating the soil and water. Testing to determine if leaking is occurring is very expensive. However, cleaning up contamination can cost as much as $50 million.

Jake Summers, Sanitation Engineer

The current landfill will be completely filled in less than two years. The proposed landfill can be built at a cost of $78,000. It will cover 10.3 acres of land. At the rate at which Greenville's garbage production is increasing, this facility should last the city about 20 years. Because of its increased capacity, the city should consider hiring an additional 25 workers to pick up, haul, and manage the solid waste at the landfill site. Every regulation will be followed to ensure that this new landfill will be safe and will not cause pollution.

Ed Winters, Environmental Consultant

I have very mixed concerns about both of the suggested waste disposal facilities. The landfill will be built adjacent to the existing facility, but the proposed area will also use part of the land that has been set aside as a wildlife preserve. This area has been a favorite for hikers campers, and birdwatchers. The proposed landfill could endanger the wildlife. Unless the city is very careful about disposal of hazardous chemicals in this new landfill, air and water pollution could be a problem.

Maggie Henry, Construction Engineer

The incineration facility that has been proposed for Greenville will cost approximately $12.3 million and will be able to handle 450 tons of garbage per day. If all safety specifications are followed, air pollution will be minimized. Because the ash that results from the burned garbage has been classified as a hazardous waste by the EPA, it will need to be disposed of safely. The Morrison landfill has agreed to let Greenville dispose of its ash there if properly stored in sealed barrels. This will add an additional $55,000 per year in disposal costs.

Gary Miller, City Personnel Manager

Both of the proposed facilities have economic pros and cons. I have listed those in a chart.

Landfill –

Pros: Will provide adequate garbage disposal for 20 years.
If monitored, will not cause air pollution.
Is less expensive than incineration facility.
Will employ 25 new individuals.

Cons: Has the potential to cause groundwater pollution.
Has a limited life (20 years).
Will damage part of the wildlife preserve.

Incinerator –

Pros: Can handle 450 tons of garbage per day.
Will employ 43 new workers.
Will provide some of the heat and electrical energy for the city, saving the city $35,000 per year.

Cons: Will cost an additional $55,000 per year to dispose of toxic ash.
Could be a source of air pollution, particularly dioxins, which are hazardous to health.

COOPERATION PLANNING WORKSHEET

Grade Level: ____________________

Science Course(s) Taught: ______________________________

Social Studies Course(s) Taught: __________________________

Possible STS Topics/Issues Applicable to Both Courses

____

____

____

____

Forms of Cooperation We Will Try During the Next Semester:

_____Sharing of notes to look for connections

_____Setting objectives to take advantage of connections and to highlight bridges

_____Joint planning of concurrent, mutually supportive units

_____Joint planning of an integrated unit

_____Team teaching of an integrated unit

_____Team teaching of an integrated course

_____Other: ____

____

Administrative Support or Approval Required.

____

We will begin our cooperative efforts by doing the following:

____

____

____

Date for next meeting: __________________________

CASE STUDY 1: ENERGY AND US

Kelly Walsh High School is located in Casper, Wyoming, a community of approximately 50,000 people. Kelly Walsh has 1,300 students and 85 teachers in grades 10 to 12.

Energy and Us was conceptualized after the fall of 1972, following a major temperature inversion caused in part from a blanket of smog from the Dave Johnston Power Plant 25 miles east of Casper. A survey about the incident revealed how little students knew about the production and use of electrical energy and the environmental implications of the process. Science teacher Elizabeth Horsch and social studies teacher Roxie Dever decided to develop an integrated course using the power plant as a case study. Pacific Power and Light Company, owners of the plant, agreed to provide assistance with projects.

Students brainstormed questions about the power plant; based on student input, the aspects of the power plant that would be studied and the "people" impacts that could be examined were outlined.

Since that first year, each subsequent year's case study has been different with respect to topic design, materials used, and activities. The common threads are the use of student questions to shape the study and the focus on science-related social issues—land use, the degradation of a natural stream by development, the pollution of the river by a poorly operated sewage treatment plant, the conflict between the mining of gravel and the development of a state park.

In addition to the case study each year, units on other topics (natural resources, land use, energy, governmental process, personal energy consumption, critical thinking) are included to give students a general background. The length of these units varies depending on the time required for the case study and the relevance of the materials to the case study. The units can be coordinated into or team taught by social studies and science teachers. For example, a unit on energy consumption and packaging was used in an American problems class as well as chemistry.

The goals for this project have been to:

- Develop positive attitudes toward science and its relevance to the individual, society, and the environment.
- Develop and apply, through science experiences, rational and creative thought processes.
- Employ the language, tools, and materials of science for collecting, organizing, and communicating information.
- Acquire and apply scientific knowledge, concepts, laws, and principles to interpret the natural world.
- Use science experience as a means of fulfilling personal aspirations.

Students are given responsibility for designing the study and keeping track of data. They are also given a major role in drawing conclusions and in disseminating study results. Efforts are made to develop a close working relationship between students and the community.

The teachers' role is to facilitate small-group work, direct lessons that provide background information, arrange for guest speakers, plan field trips, do community public relations, direct lab experiments, and search for relevant information of a particular project.

Student evaluation is based on class participation, record keeping, tests, and participation in out-of-class activities. The best evaluation instrument is the student notebook. Evaluation of the program is based on student interest, response, participation in community affair, and the continuing concern and interest of students who have completed the class. The team teachers also mutually evaluate the effectiveness of instruction.

Benefits identified by participants include:

- Students and teachers learned to work closely with each other and with the community.
- Both students and teachers developed a broader understanding and knowledge of science and social issues.
- Fellow teachers provided a pool of expertise.
- Students were depended upon to help with various components of the project
- A textbook was not used.
- Teachers became more flexible and responsive to student interests and abilities.
- Students learned how to investigate actual problems with no predetermined answer.
- Latitude was provided for individual students to determine which aspect of a study they wished to pursue.
- Latitude was provided by the administration for selecting topics, selecting materials and guest speakers, involving the community, scheduling the class, using a common planning period, and facilitating transportation.
- Class members learned to rely on each other.
- Program evaluation was shared with students.
- Contact was made with interesting people from government, business, industry, and the community.

The drawbacks of this type of project include:

- Because developed materials or a textbook were not being used, unexpected situations and problems often occurred.
- Being able to tailor parts of the activities for both interest and ability level was very difficult.
- The lack of activity demonstrated by some students was very obvious.
- One team or a few members of a team often failed to produce results for which they were responsible.
- Evaluation of the individual students for grading purposes was quite difficult.
- Planning and implementation of this program required a major time commitment, necessitating the use of a paraprofessional to help with planning.
- A retrieval system for identifying available materials would have been useful.

Note: Horsch and Dever had hoped this program would be an ongoing one at Kelly Walsh High School. Because of a change in curriculum guides, however, this program was discontinued.

CASE STUDY 2: HUMAN ECOLOGY

The Brandywine School District, which includes Brandywine and Concord High Schools, is in northern New Castle County, Delaware. Brandywine High School has 1,100 students and 70 teachers, grades 9 through 12. Concord High School has a bit larger student population and 10 additional teachers.

The Human Ecology program began at Brandywine High School in September 1980. The program was introduced at Concord High School in September 1982. This program attempts to provide instruction giving students the knowledge, skills, and attitudes they need to become active forces in the improvement of the human condition. The course brings together the subjects of social studies and science to give students a comprehensive look at the human condition today and where it appears headed in the future. The course enables students to see how people, society, and nature relate to one another, and how these factors affect their own well-being as well as that of the people around them.

Jack Carney, who developed the concept of the Human Ecology program, presented the model to the New Castle County School District's Curriculum Council. The model was approved for possible instruction in the schools. In 1979, an ad hoc committee met with Carney to develop a curriculum program in Human Ecology. The school district administration made a commitment to the basic concept, the model, and inservice training for the development of the program. Since the inception of the program, one teacher unit has been committed to the program. Federal funding was obtained for inservice training. Funds were also provided to support teacher summer curriculum development workshops for three years.

The Human Ecology program was introduced as a science elective course, with the central focus of the program being the development of the human and the well-being of individuals and families in their social and physical environments. The following content areas are especially pertinent:

- Patterns of reproduction and child-rearing practices that reduce the probability of future physical and mental handicaps, including the influence of substance abuse, infection and nutrition on the growth of the fetus, and the importance of sound child care during early stages of development.
- Elements necessary for or detrimental to the psychological health of human beings, such as psychological and physiological characteristics of stress and the coping skills to mediate stress; cause and prevention of teen-age suicide.
- Physical factors of the natural environment (water and air pollution, land usage, and energy) that interfere with the optimal growth and development of human beings. Specific problem areas covered are population growth, solar and nuclear energy, and environmental pollution.
- Factors responsible for the development of healthy individuals and families according to recognized authorities, such as stages of human development, factors important to the selection of a marriage partner, and roles and functions of a family.
- Development of positive human relationships, the ways of improving effective human relation skills, and the benefits derived from practicing effective human relation skills.

Student goals include:

- Developing an appreciation for the beauty of knowing vs. not knowing.
- Seeing the history of scientific discovery in relation to the career efforts of living people.
- Recognizing the value of scientific research in making people's lives more productive.
- Knowing that the study of science is fun, profitable, and mind-expanding.
- Feeling that scientific knowledge belongs in the mind, not just in the lab.
- Acquiring habits and attitudes necessary for responsible citizenship.

- Developing a concern for moral, ethical, and spiritual values.
- Developing an appreciation for one's worth as a member of society.

Students use roleplays as a way to learn about the content of the various topics within the program. This process also affords them the opportunity to formulate their own attitudes and ideas while gaining insight into the attitudes and ideas of other people. Additionally, listening and discussing various topics, giving oral presentations to the class, participating in cooperative group learning, viewing and discussing audiovisual presentations, and participating in community service volunteer activities are learning strategies that are employed.

The course is team-taught, with guest instructors from various disciplines and places of employment used to enrich the program. This approach has been effective in maintaining student interest and motivation.

The community service component of the program exposes students to the vast mechanisms society has developed to deal with the effects of human suffering and seeks to help students understand how to avoid or change negative behaviors. As part of this community service program, students:

- Participate in a self-inventory.
- Work on improvement of relationships with school peers.
- Focus on the physical and psychological development of the human.
- Relate norms or developmental benchmarks to their own development.
- Study the influence of social institutions, marriage, family, and religion on human development and self-development.
- Learn about the influence of the physical environment on the development of humans.
- Help neighbors through volunteer service in a human service community agency.

Students are evaluated in the traditional manner, through four major tests, a final exam, teacher observations, and their participation in the community service volunteer activity. Pre/post evaluative data is available. Teachers are also evaluated through formal district-wide teacher evaluation programs and observations each year.

The benefits of this program are many:

- The value, ethical, and moral considerations of science-related social issues become important as students become more aware of the values and attitudes of their peers.
- Support is given to the program through a variety of channels. The superintendent supports the program by assigning a teacher unit to the program. Funds are also provided for curriculum materials and professional travel.
- Adjunct financial support has been provided by the March of Dimes Birth Defect Foundation.
- Students take an active role in planning and implementing new additions to the program.

Enhancements or changes that could improve this program include:

- Addition of a stronger humanities component.
- Use of the program by more teachers.
- Start-up funds and a strong commitment by administrators and staff to launch the program at a new school.
- Funding coordinator to monitor the program on a regular basis.

CASE STUDY 3: ECOLOGY AND THE COMMUNITY

Jamestown, Rhode Island, with a population of 4,000 is the only town on Coananicut Island in Narragansett Bay. With modest resources, teachers and administrators still focus on quality education as a major priority, thus consistently scoring at the top of the state in standardized testing, competitive grants, and awards. The community has only one school—the Jamestown School, which houses 500 students in grades K through 8.

The Ecology and the Community program was initiated to prepare future voters to understand their roles and responsibilities as determiners of alternative futures. Ecology and the Community begins during the fall of the seventh-grade year. Science components of this program include:

- The principle parts and functions of the cell.
- Photosynthesis and respiration.
- Food chains, food webs, and feeding relationships.
- Decay organisms and their role in feeding relationships.
- Population-limiting factors in the environment.
- Basic genetics.
- Selection, adaptation, and long-term change.

Students undertake an extensive investigation of an outdoor site each spring. This field investigation allows for direct experience with the concepts presented earlier in the year.

Of equal importance is the concurrent study of the community. In order to provide a balance necessary to avoid a prejudicial, pro-environment point of view, students learn about the realities of community costs and limited financial resources. Social studies components of the program include:

- Basic economics.
- Recent local history and community background.
- Town government.
- Town services and costs.
- Town industries and businesses.
- Taxes.
- Town budget.
- Jobs and the job market.

The social studies topics are addressed through a series of activities, simulations, interviews, personal research, and guest speakers. Students draw parallels between their community and the environment. For example, students compare the impact on a herd of deer and a 10-percent decrease in food supply to the impact on their community and a 10-percent loss of jobs.

The culmination of the Ecology and the Community year of study is a series of simulations in which students must make difficult choices between environmental and community concerns. The seventh-graders present both sides of an environmental question and hold a schoolwide referendum.

The second phase of this program occurs when the seventh-graders move into the eighth grade. At this point, the students undertake cross-age teaching. Teams of two student volunteers present Ecology and the Community lessons to students from grades K through 6. These lessons are planned by the sending teacher, the receiving teacher, and the student team members. From these opportunities, student knowledge is reinforced, the experiences of the younger students are broadened, and the overall impact of the program is enhanced.

This program is evaluated through pre/post testing, with on-site visitations, and from follow-up questionnaires In spite of three revisions of the program, however, the designers of this course have been unable to demonstrate conclusi[illegible] results through the formal pre/post testing instruments. One theory about the lack of evidence indicating significant change, primarily in the affective domain, is that seventh-graders may have internalized the informed decision-making process but are not yet able to verbalize it.

A small number of returns from follow-up questionnaires mailed to high school graduates who participated in this program indicates that five years later, participants do show signs of being thoughtful participants in citizen decision making.

Identified strengths of the program include:

- The needs of the community were the benchmark for evaluating the program.
- Ecology and the Community is an easily transported program. Teachers with a variety of temperaments and styles have had equal success with the program.
- Implementation in another school can occur without schedule changes or radical changes in school philosophy.
- The cost of adopting the program is low because the amount of new materials to be purchased is small.
- Flexible activities ensure accomplishment of objectives.
- Students are actively involved.
- Social issues are united with science to produce a good hybrid program.
- Cross-age teaching teams work ve[illegible] effectively and help maximize the impact of financial support.

HOW CAN WE PLAN AN STS COURSE?

Background Notes

Paul DeHart Hurd has argued that "knowledge, whether of facts or methods, gains meaning from the context in which it is used. Strictly discipline-based courses are too constrained to convey the full meaning of much that is taught. Facts are learned, but many are largely inert and have little effect on daily life.... The STS theme is designed to make the study of science productive for more students by encouraging students to think about the social and personal implications of what they are learning." By developing a stand-alone STS course—whether semester- or year-long—this goal can be pursued daily, not just on selected occasions in existing courses.

This activity is designed to provide some guidance in developing an STS course or lengthy STS unit. It is assumed that the activity would be used only with a group empowered to make the types of decisions called for—selecting content, writing objectives, deciding how to organize the course, and so on.

In many cases where an STS course has been decided upon, a rationale for the program has already been established by a policy-making agency such as the state department of education or school board. However, if this is not the case, it would be important to precede this activity with the two activities from Chapter 3; these activities should then be followed by drafting of a formal rationale statement.

Once a rationale has been written, content for the course must be selected. Selecting content is the major focus of this activity, which presents guidelines for developing knowledge, skill, and attitude objectives, and involves participants in beginning the content selection process. Subsequent steps, including selection and development of materials, decisions about teaching strategies, and program evaluation decisions, can be taken using other activities in this manual.

Conducting the Activity

Materials Needed: Copies of Handouts 13, 21, and 22 for all participants; transparencies A, D, E, F, G, H, I and J, overhead projector; poster paper, tape, markers; any district or state guidelines related to the new STS course (if the guidelines include a statement of program goals, you may wish to reproduce these on a handout or transparency)

Activity Objectives: Participants should be able to (1) describe criteria for selecting knowledge, skill, and attitude objectives for an STS course, (2) develop major program goals for an STS course, (3) select key concepts and issues for coverage, and (4) develop a work plan for completing content selection, objective development, and course organization.

Suggested Steps:

1. Remind participants of the rationale statement adopted for their STS course. This rationale statement will serve as a guidepost in selecting the content to be covered and the strategies to be used in presenting that content.

2 If district or state course guidelines identify major program goals, go over these goals with participants, discussing their implications for selection of content. If no such goal statements exist, project Transparencies H, I, and J, going over each in turn. Then divide the group into three smaller groups, assigning each group one area—content, skills, or attitudes. Using the guidelines presented in the transparencies, have each group develop three or four program goal statements related to their assigned area. The statements should be posted on posting paper. After about 15 minutes, have the

groups circulate, so that each group is reviewing another group's statements. They should make additions or changes to the statements. Allow about 10 minutes for this task, and have the groups move on to the area they have not yet considered, again commenting on the work of the preceding groups. When this task has been completed, go over all the posting sheets as a large group, working toward consensus. It is not necessary to have final agreement on the goal statements at this time. A smaller working group can be assigned to complete this task after the workshop. Leave the goal statements posted prominently in the room for the remainder of the session.

3. Point out that three related tasks must be accomplished now that major program goals have been written: (1) selecting content (knowledge, skills, and attitudes) to be covered in the course, (2) writing specific objectives for student outcomes, and (3) deciding how to organize the course. The remainder of this activity will focus on selecting content, particularly knowledge, to be covered.

4. Explain that in trying to choose specific content to be covered, many planning groups end up with a list that is impossible to implement because they have not set sufficient parameters. Write this question on a piece of posting paper: "Given a limited amount of instructional time, what big ideas about life and living should our students carry away from their STS course for use throughout the rest of their lives?" Ask participants to identify the four parameters embodied in the question. (That time is limited; that the course should cover big ideas in life, not big ideas in science; that the content must be usable—applicable to life; and that use should continue throughout the student's lifetime.) If participants disagree with any of these presumptions, the question can be revised; however, the purpose is to develop a guiding question that provides some parameters for selecting content for the course.

5. Remind participants that there are three kinds of STS knowledge—interactions, concepts, and issues. Use Transparencies A, D, and E to explicate these three kinds of knowledge, allowing time for discussion of each, as well as time to add additional items to the list of issues.

6. Distribute Handout 21, giving participants approximately 10 minutes to complete it individually. While they are working on it, make posting sheets that list the concepts and issues being ranked.

7. Collect the handouts. Distribute Handouts 22 and 13 for participants to read while you tally the responses for each of the items in each category; write the totals on the posting sheets listing all the options. Transparencies F and G should be available for participants' use as they read the handouts; multiple copies of these transparencies might be more helpful than projecting them.

8. Go over the rankings with the group, pointing out the items with the lowest total scores, which are concepts or issues on which there was general agreement as to their importance. They should be given top priority in selecting content for the program. Those items with the highest scores are those generally ranked as unimportant; they can probably be eliminated from consideration. Items with scores in the middle have either been consistently ranked as of middling importance or have provoked a high degree of disagreement. These items will need further discussion before decisions are made on their inclusion in the course. The availability of appropriate instructional materials might be a factor in deciding between concepts or issues on which there is disagreement or no strong preference.

9. Discuss the information provided on Handouts 22 and 13. Then help the group develop a work plan—including designation of subcommittees, if necessary—to complete the selection of content, writing of objectives, and development of a course outline. Be sure that participants understand that drafts of documents produced by subcommittees should be reviewed by other members of the group as well, to continue the consensus-building process begun in this activity. Deadline dates for each phase of the process—including reviews—should be established.

STS CONCEPTS AND ISSUES WORKSHEET

Read each list below. Fill in any additional concepts or issues suggested by the group. Then rank the concepts from 1 to 10, with 1 being the most important concept to cover in an STS course and 10 being the least important concept. Rank the issues from 1 to 12, again with 1 being the most important item for coverage and 12 the least important.

STS Concepts

_____ Systems and Subsystems

_____ Organization and Identity

_____ Hierarchy and Diversity

_____ Interaction and Change

_____ Growth and Cycles

_____ Patterns and Processes

_____ Probability and Prediction

_____ Conservation and Degradation

_____ Adaptation and Limitation

_____ Equilibrium and Sustainability

_____ ______________________________

_____ ______________________________

STS Issues

_____ Population Growth

_____ Water Resources

_____ World Hunger and Food Resources

_____ Air Quality and Atmosphere

_____ War Technology

_____ Energy Shortages

_____ Land Use

_____ Human Health and Disease

_____ Hazardous Substances

_____ Extinction of Plants and Animals

_____ Nuclear Reactors

_____ Mineral Resources

_____ ______________________________

_____ ______________________________

COMPLETING THE COURSE OUTLINE

You have begun the process of developing your course outline by considering concepts and issues to be covered in the STS course. Several steps remain before you will have a completed course outline. These steps are described briefly below. As you read through them, think about an action plan that would allow your group to complete each step in an efficient manner.

Complete Selection of Content

When the group's responses to Handout 21 are tallied and analyzed, you will have identified some concepts and issues for coverage and eliminated some others. A middle group will remain to be considered. In deciding among issues or concepts on which there is no consensus, the availability of instructional materials that address the issue or concept may be a determining factor. Thus, it is advisable to begin looking for and at instructional materials. This will also help you identify whether you will need to develop materials on the issues and concepts you have definitely decided to include in the course.

You will also need to identify the skills and attitudes that you wish to address. Transparencies F and G provide lists that may be helpful in this process. You may find it possible to include all of the listed skills and attitudes in the course.

Remember, the goal statements your group has decided on should guide all your decisions related to selection of content.

Action Plan for Completing Selection of Course Content:

Write Specific Objectives (Student Outcomes)

Student outcomes define more clearly the expectations for students. Outcome statements should be sufficiently specific to permit measurement. This is an important aspect of planning for an accountable program. Some examples of "measurable" objectives are given below:

- Students will be able to list six significant events in the history of energy use in the United States.
- Students will be able to classify alternatives related to population growth according to steps that enlarge individual and societal freedoms, steps in which an individual gives up some freedoms for the betterment of society, and steps that greatly limit the freedom of individuals.
- Students will react positively to scenarios in which individuals take action to influence public policy on science-related social issues.

It is helpful in writing objectives to use action verbs. A number of action verbs are provided in Handout 13.

Action Plan for Writing Specific Objectives:

Outline the Course

Depending on the content selected for coverage in your course, you will have several options for organizing the course. You may even choose to allow teachers to organize the course in whatever manner they select.

Many STS courses are organized around selected issues, with concepts, interactions, skills, and attitudes developed through in-depth examination of those issues; students may, in fact, be asked to go beyond examination to action on an issue. However, courses could also be organized around scientific concepts and principles, proceeding from there to the technological processes and devices that arose from the concept or principle or allowed the concept or principle to be discovered, and to the social issues that arise from the scientific concepts or principles. A course might even be organized around technological processes and devices. Either of these organizational schemes could also involve an action component if appropriate for your community.

The choice of how to organize the course will depend on the emphasis you wish to give the course, the materials that are available, and the comfort-level of teachers. For example, social studies teachers may be more familiar and therefore more comfortable with an issues-oriented approach while science teachers may find a concept-based organizational scheme easier to implement. The teachers who will be presenting the course should be considered in developing the final course outline.

Action Plan for Outlining the Course:

HOW CAN WE AVOID PITFALLS IN INTRODUCING STS?

Background Notes

Exactly how a school district goes about implementing a program depends to a large extent on the components of that program. Nevertheless, whatever its components, you can be sure that a program will not install itself. Research indicates that success in bringing about change is positively related to the extent of effort made on behalf of that change. If the program is going to survive, it must receive support from the community. Involving community representatives from the beginning will make it much easier to build support among parents, civic groups, the media, and the public in general. You will need to use every possible avenue to inform people about what you are doing and why. School newsletters, radio talk shows, articles in the local newspaper, speeches to civic organizations and parent-teacher groups, school open houses – use them all.

If community representatives are brought in at the implementation stage, there is one little "hooker" to watch out for. One of the most common reasons for failure in implementing a new program is incompatibility with local values. In the process of revising a curriculum and designing an evaluation system, it is easy to forget that members of the community, not educators, are the clients. If planners lose sight of that fact, they may discover that the new program "scratches where the public doesn't itch."

The fact that the STS program is being designed by the very people who will implement it is a big plus in terms of installing the program. Educators are fond of talking about how teachers should take into account the individual differences of students; that is not bad advice to curriculum planners as they put a new program into operation. Not all teachers accept change at the same rate, and they need to be given opportunities to express their concerns and doubts. This is more likely to happen if the issue can be depersonalized – for example, a question to a teacher could be phrased as "What are some of the things that might go wrong with this new program, and what can we do to avoid them?" rather than as "What makes *you* most uncomfortable about this new program?" This activity is designed to help classroom teachers understand and deal with some of the problems that may arise in installing the program.

Conducting the Activity

Materials Needed: Sufficient copies of Handouts 23, 24, and 25; ten 3" x 5" cards for each participant; you may find it useful to have copies of the material on controversial issues from Appendix B.

Activity Objectives: Participants should be able to (1) express their concerns and doubts about the new program, (2) identify problems that may arise with the program, (3) outline some actions to help install the program.

Suggested Steps:

1. Explain to the participants that you want them to help project some of the future problems and payoffs of the new STS curriculum plan. Give each person ten 3" x 5" cards asking them to put one statement on each card. Each statement should begin in one of two ways: (a) "A problem that is likely to be caused by this program is ..." or (b) "One of the positive payoffs that we can anticipate from this program is ..." Participants should not put their names on the cards. Allow ten minutes for this step. (Note: The group leader should also fill out ten cards in order to make sure that all ideas that need to be discussed are on cards – especially problems or payoffs that others are likely to think of but might be reluctant to write down.)

Adapted from *Program Planning Handbook*, edited by James E. Davis (Boulder, CO: Social Science Education Consortium, 1983). Activity developed by Gerald Marker.

2. Collect the cards and put them in a central location. If the participants are to work in small groups during the rest of the activity, each small group should have its own stack of cards.

3. Distribute Handout 23, "Example of Force-Field Analysis." Explain that force-field analysis is a technique used to analyze a current situation in light of a goal for change. A situation exists as it does because both positive and negative forces operate to maintain the status quo. Force-field analysis enables those seeking change to examine the forces that support the goal and the forces that may prevent the goal from being reached.

In the example, the goal has been stated with a time deadline and a specification of the number of people to be involved in the change. Both supporting and restraining forces have been identified with n the individual who is responsible for helping make the change happen (self), significant others, and relevant institutions. Note that these are only samples of forces; a thorough analysis would reveal numerous additional restraining and supporting forces.

4. Distribute Handout 24, "Force-Field Analysis Worksheet." Explain that the group's task will be to (a) state an installation goal, (b) identify the supporting and restraining forces, (c) evaluate the strength or importance of each force, and (d) identify possible strategies for dealing with one or more restraining forces. (**Note:** The central idea in achieving effective change is to remove the restraining forces rather than to increase the strength of the supporting forces.)

5. As the first step in the analysis, the participants should state an installation goal. They should then take the cards one at a time and list them on their worksheets as "supporting forces" or "restraining forces," indicating whether they belong under "self," "significant others," or "institution."

6. Caution the participants not to try to compile an extensive list of supporting forces. Rather, each group should identify at least one restraining force and develop an action plan to reduce the strength of that force.

7 Distribute Handout 25, "Action Plan Worksheet." Explain that the first step is to try to reduce the strength of or remove a restraining force. Ask each group of participants to choose a restraining force and then identify action ideas for dealing with the force. They should work all the way through one selected action idea, indicating each step in the action plan; who will do it; where, when, and how; and what special resources will be needed.

8. If participants are working in small groups, ask each group to share its action plan worksheet with the whole group. Some groups may have identified the same restraining forces but developed quite different action plans. Discussion of action alternatives will be very useful. If time allows you may ask each small group to choose a second restraining force and develop a second action plan.

If any of the groups choose resistance to dealing with controversial issues as the restraining force to analyze, you may want to make the material on controversial issues from Appendix B available to them.

EXAMPLE OF FORCE-FIELD ANALYSIS

Your stated goal: *By October 15, 40 junior high teachers in four district schools will begin using the STS interdisciplinary unit in their classrooms.*

Supporting Forces – >	< – Restraining Forces
Self	
I am confident of good planning. ~ ~ etc.	*I don't know how to conduct good inservice programs.* ~ etc.
Significant Others	
We have school board support. ~ ~ etc.	*One junior high principal opposes the unit.* ~ etc.
Institution	
State mandates support this approach. ~ ~ etc.	*We do not have adequate funding for field trips.* ~ etc.

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FORCE-FIELD ANALYSIS WORKSHEET

Your stated goal: ____

____

____

____

Supporting Forces – >		< – Restraining Forces
	Self	
	Significant Others	
	Institution	

ACTION PLAN WORKSHEET

Force selected to work on: ______________________________

____

____

Goal: ______________________________

____

____

Action idea(s) chosen: ______________________________

____

____

What will be done?	Who will do it?	Where and when?	How?	Special resources needed

Handout 25

6. EVALUATING STS PROGRAMS

General training objectives addressed by the activities in this chapter include:

- To provide participants with the skills needed to evaluate their STS program.
- To provide participants with tools for evaluating student learning in STS.

HOW CAN WE EVALUATE AND IMPROVE OUR PROGRAM?

Background Notes

Planning a sound program evaluation is vital to the success of a new curriculum plan. By being thoughtful about evaluation, planners and teachers demonstrate their belief that what they have planned is important. An effective program evaluation can answer the inevitable questions about program workability and provide data to improve the program.

A major function of program evaluation is to demonstrate to a variety of groups the effectiveness of the instructional program. An effective program of evaluation is many-faceted and displays the following characteristics:

1. It is based on clear and specific objectives.

2. It is continuous and cumulative, with records kept by administrators, teachers, and students.

3. It includes as many objective methods of evaluation as possible.

4. It includes subjective material (observations, case studies, diaries) that can be used to support objective results.

5. It is carried on daily through informal methods as well as at frequent intervals with more formal instruments.

6. It includes planning by teachers and administrators for using evaluation data fully and effectively.

7. It is wisely interpreted to students, parents, and others.

8. It does not unduly emphasize any one socioeconomic class.

9. It includes controlled teacher experimentation with new methods and devices.

10. It includes or involves students, parents, and administrators.

For evaluation to serve as a program improvement tool, it must provide some appraisal of the extent to which all aspects of the program are successful/unsuccessful. The process not only provides a blueprint of strengths and weaknesses for both the individual and the group, but also serves as guide for future planning by all involved.

Unfortunately the word "evaluation" has a negative connotation for many educators. Thus, emphasizing the benefits of a sound evaluation is important. Evaluation should not be viewed as a mechanism for identifying who is not doing a good job, but as a tool for helping educators do an even better one.

Adapted from *Program Planning Handbook*, edited by James E. Davis (Boulder, CO: Social Science Education Consortium, 1983). Some of the original ideas for this section were contributed by staff members of the Texas Education Agency.

Conducting the Activity

Materials Needed: Sufficient copies of Handouts 26 and 27; newsprint, marking pens, and masking tape.

Activity Objective: Participants should be able to (1) determine what program evaluation information should be collected, (2) decide how the information will be collected, (3) decide what will be done with collected information, and (4) set evaluation priorities.

Suggested Steps:

1. Review with the group the general characteristics of program evaluation, using the Background Notes if desired.

2. Distribute Handout 26, "Planning for Program Evaluation." Allow time for reading and discussion.

3. Distribute Handout 27, "Priorities for Program Evaluation." (You might also wish to post a newsprint copy of the matrix in order to collect ideas from the planning group.) Ask participants to fill in the handout as completely as they can. Here are some examples you might suggest:

Sources	What Info?	How?	What Done?
Students	Standardized Tests	Administer in Spring	Report to counselors and parents
Teachers	Survey Forms (specify criteria)	Administer in December and May	Report in writing to all
Building Adm.	Observations (specify criteria)	Written diaries	Report to planning committee
Parents	Survey (specify criteria)	Sample telephone survey	Summary report to committee and board

4. Announce that because all sources of information cannot be tapped, some priorities must be set. Ask the group to discuss what the evaluation priorities should be, keeping in mind that the program is new. Decide on the priorities and proceed with detailed planning. Planning should address: (1) Instrumentation design; (2) research design, if needed: (3) timing; (4) data analysis procedures; (5) report preparation; and (6) reporting.

PLANNING FOR PROGRAM EVALUATION

Planning for effective program evaluation requires that (1) the goals of the program have been decided upon and (2) the means by which program goals will be attained have been selected. Once the rationale, goals, and student outcomes have been selected, course content has been chosen, and curriculum materials have been identified and selected, the purposes of program evaluation can be defined. What areas are of most concern? On what aspects of the program should data be collected? What will be done with the findings? To whom will the findings be presented?

This handout raises a series of questions that can help program planners decide on the most appropriate plan for evaluating a new STS program. The handout suggests some concerns of teachers, school officials, and parents.

Teachers. Teachers may have several reasons for evaluating the program. One concern may be the appropriateness of the program goals, another the usefulness of the selected curriculum materials in helping students learn. Teachers may also want to compare the results of the new program with the results of similar programs in other parts of the state or nation. Questions that might be of interest are:

1. Are the objectives for (my) course of study appropriate?

2. Can my students attain the student outcomes?

3. How useful are the selected materials in helping students learn?

4. What training do I need in order to best use new materials?

5. What kinds of support do I need in order to effectively carry out the program?

School Officials. A comprehensive evaluation of the STS program should reveal not only strengths but also areas for improvements. Questions that school officials might ask are:

1. What are the strengths and weaknesses of the STS program?

2. Is the current STS program achieving district-wide goals and objectives?

3. What type of changes and/or experimentations should be conducted to improve the instructional program?

4. What are the educational gains of our students as compared to those of students in other districts?

5. What are the strengths and weaknesses of the STS teachers?

6. What inservice programs appear to be needed?

Parents. As long as school is seen as a means of advancement or as a way of securing a place in society and as long as parents have hopes and fears for their children, parents will be concerned about children's educational progress. A school evaluation program should, therefore, involve parents in the process as educational partners. Questions that parents might ask are:

1. How good is the local STS program?

2. Are students gaining in skills and knowledge as a result of the program?

3. Are the different educational needs of all students being met by the program?

4. Are teachers trying different methods of teaching to meet the needs of the students?

5. Are the evaluation data used to help the students progress in the instructional program?

6. How can the evaluation data be used by parents to help teachers help students?

Many individuals and groups have a legitimate interest in how students are progressing and in what kind of job the schools are doing in meeting the educational needs of students. It is important for educators to remember that the purpose of program evaluation is to provide feedback and guidance to the whole educational process at every level.

PRIORITIES FOR PROGRAM EVALUATION

Sources of Information	What Information Will Be Obtained?	How Will Information Be Obtained?	What Will Be Done With Collected Information?
Students			
Teachers			
Building Administrators			
Building Support Staff (e.g., Counselors)			
Central Office Staff (identify)			
School Board Members			
Parents			
Other (e.g., Outside Expert Observers)			

Handout 27

HOW CAN WE EVALUATE STUDENT LEARNING?

Background Notes

The substance of education in STS demands use of a range of teaching strategies, but many teachers hesitate to employ nontraditional strategies because they suspect that what students learn from such activities will be difficult to evaluate. Teachers may need to be reminded that assessment of student achievement depends on the objectives of the lesson or unit, regardless of the teaching techniques used. Thus, many of the same techniques used in evaluating learning resulting from traditional teaching methods can be employed.

This activity is designed to remind teachers of that fact and to familiarize them with strategies that can be used to evaluate achievement of knowledge, skill, and attitude objectives.

Conducting the Activity

Materials Needed: Copies of Handout 28; if possible, it would be useful to have participants bring examples of their own quizzes or tests related to STS content.

Activity Objectives: Participants should be able to (1) describe four general methods of evaluating student learning in STS education, (2) illustrate each of these techniques with an example related to STS, and (3) list at least two advantages and two disadvantages related to each of these evaluation techniques.

Suggested Steps:

1. Tell participants that teachers at other STS workshops around the country have expressed concern about implementing alternative teaching strategies, such as role plays and problem-solving exercises, because they believe what students learn from such activities is difficult to evaluate. Why might this be true or untrue? What parts of a lesson or unit are most important in determining how student learning will be evaluated? (Objectives) If objectives are written properly, should the teaching strategy used affect how the learning is evaluated? (In most cases no; in some cases, the strategy may result in student products that can be evaluated.)

2. Tell participants that before one selec appropriate evaluation techniques, each technique must be explored to grasp its advantages and disadvantages. Distribute copies of Handout 28. Allow participants time to read this paper.

3. Conduct a full-group discussion to clarify the main points of this paper and to answer any questions participants have about the techniques.

4. Ask participants to classify the items on their tests or quizzes into the four methods. Which method or methods do they use most often? Which other methods would be appropriate? Have participants work in pairs to develop an item or two using one of the methods they don't currently use.

5. Conclude by stating that selection of evaluation techniques always involves trade-offs—rarely can you choose the ideal instrument with no disadvantages. The best you can do is make the best possible selection and be aware of its limitations. It is important to remember that although teachers may have to plan a bit more carefully to evaluate learning that results from use of alternative strategies, the benefits are well worth it.

ASSESSING STUDENT LEARNING AND ATTITUDES

Just as different forms of teaching can be useful in the area of science-related issues, so too are there various ways of gaining evidence on student learning and attitudes in this area. Good assessment can help clarify for students what they are expected to learn, how much progress they are making, where they need to improve, and whether they have achieved desired learning outcomes. Assessments also can help teachers plan, evaluate, and improve instruction, as well as assign grades to students.

This handout discusses and illustrates the role that can be played by objective test items, essays and related student products, questionnaires, and classroom observations in assessing student learning and attitudes. The focus is on practical suggestions and concrete examples.

Objective Test Items

Objective test items are those that can be scored with little or no subjective judgment. They consist of "response-selection" items, which require students to choose an answer from a set of options, and "response-completion" items, which require students to construct a response. The most common type of response-selection items are multiple-choice, matching, and true-false items. The most common type of response-completion items are fill-in-the-blank and short answer items.

Response-selection items, particularly multiple-choice and matching items, tend to be demanding to prepare, but easy to score. Response-completion items, such as short answers, are generally easier to prepare than response-selection items, but they are more demanding to score.

Using Objective Items to Assess Knowledge. Both response-selection and response-completion items can be used to assess what students know about the science and technology related to a social issue. Here are examples of matching, multiple-choice, and short-answer items that assess students' knowledge related to issues of human health and disease.

Example 1 (Matching item)

The diseases and disorders we have studied in this unit are named below. Following this list is a description of the diseases and disorders. Match each of the diseases/disorders listed to the corresponding description by placing the correct letter (A-H) in the blank to the left of the description. Also indicate whether the disease/disorder is caused solely by a genetic defect, or by a combination of genetic and environmental factors, by placing the letter G (genetic defect) or GE (genetic and environmental influences) in the blank to the right of each description.

List of Diseases/Disorders

A. Cervical tract syndrome
B. Color blindness
C. Cretinism
D. Down's Syndrome
E. Hemophilia
F. Huntington's chorea
G. PKU
H. Sickle-cell anemia

Causes

G Genetic defect
GE Genetic and environmental influences

Adapted from *Personal and Social Issues in Science: Lessons from the Classroom*, by Glen Fielding and Michael Fiasca (Monmouth, OR: Oregon State System of Higher Education, 1987), Chapter 4. Used by permission of the authors.

Descriptions of Diseases/Disorders (A-G)		Cause (G or GE)
________	1. A crippling, fatal disease that strikes mainly black people	________
________	2. Retardation resulting from an extra chromosome	________
________	3. A fatal disease whose symptoms may not appear until mid-life	________
________	4. Retardation that can be prevented at birth if low phenylalanine diet is prescribed	________
________	5. Blood-clotting disorder; the "royal" disease	________

(Adapted from Carlson, 1985, pp. 40-41)

Example 2 (multiple-choice item)

Which one of the following statements about Huntington's disease is TRUE? (Place a check in front of the correct answer.)

____ People often do not show signs that they inherited the disease until mid-life.

____ Long-term, carefully supervised radiation therapy sometimes cures the disease.

____ If either member of a couple has the disease, there is a 10 to 15 percent chance that they would transmit the disease to their children.

____ The disease tends to produce unusual bursts of mental or intellectual activity.

Example 3 (short-answer item)

In a few concise sentences, describe the type of services a "genetic counselor" provides.

____

____

____

____

Note that the matching question in example 1 permits a teacher to assess many facts, concepts, and relationships in a single item. This potential for comprehensive assessment of a set of related knowledge outcomes is an advantage of the matching format. If, on the other hand, a teacher wants to assess students' knowledge of a single fact, concept, or principle, a multiple-choice format is preferable, as is illustrated in example 2. Multiple-choice items permit a relatively thorough examination of students' knowledge of a particular point.

Note that the illustrative short-answer item assesses whether students can *generate*, rather than merely select, an answer. Short-answer items therefore usually are harder for students, and somewhat more representative of "real life," than multiple-choice items measuring the same objective. As indicated earlier, short-answer items also are more time-consuming to score. A balance between response-selection and short-answer items is generally desirable when assessing knowledge, in view of the advantages and disadvantages of each format.

Using Objective Items to Assess Thinking Skills. Objective items can yield information on whether or not students have acquired basic thinking skills needed to analyze and evaluate statements about science-related social issues. Here are three items illustrating how objective items might be used in this regard. The first is intended to measure students' ability to recognize testable statements. The second is intended to measure students' ability to recognize the assumptions underlying a statement. The third is designed to measure students' ability to recognize possible sources of bias.

Example 1 (Identifying testable statements):

Below are some things people say about powdered potato and fresh potato.

All except one of these statements can be checked to find out if they are true.

Put a *cross* in the box by the *one* that *cannot* be checked scientifically.

_____ A. Powdered potato is more useful than fresh potato.

_____ B. Powdered potato has less vitamin C than fresh potato.

_____ C. Powdered potato has more calories than fresh potato.

_____ D. Powdered potato has more water than fresh potato.

_____ E. Powdered potato has less protein than fresh potato.

(Adapted from DES, 1982, p. 130)

Example 2 (recognizing assumptions underlying a statement):

I want to be sure I do *not* get cholera. I plan to travel to Africa so I will get my doctor to give me a cholera shot before I fly there. Place an A in front of the statement that is a correct assumption.

_____ If I don't get the shots I will get cholera.

_____ Taking cholera shots will prevent my getting the disease.

_____ Typhoid fever is more common in Africa than where I live.

(Fiasca, n.d., p. 29)

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Example 3 (recognizing possible sources of bias or conflicts of interest)

Which one of the following sources of information on the environmental effects of industrial pollution is likely to be most **objective**? (check the space in front of the correct answer)

_____ A. The President of Selpo Manufacturing, which is located on the banks of the Hudson River

_____ B. A report prepared by a panel of university scientists, industrial engineers, and government researchers

_____ C. A position paper prepared by the Union for Free Enterprise, an organization dedicated to decreasing government regulation of business

_____ D. A mother whose daughter experienced serious health problems after swimming in a polluted lake.

Short answers also can yield valuable information on students' critical thinking skills. Two examples of short answers follow:

Example 1

John said, "Coffee is a bad drink." John's statement is too vague to be scientifically checked or "tested." Restate John's statement so it could be checked.

____

____

____

____

Example 2

Sally's uncle ate an unusually large amount of nuts and berries each week of his adult life. At age 45, without warning, he died of a heart attack. Sally concluded that nuts and berries increase the risk of heart attacks.

Was Sally justified in drawing this conclusion? Explain.

____

____

____

____

Note that all of the examples above pertaining to thinking skills deal with simple, nontechnical situations. The reason for using such day-to-day situations is to see whether students have acquired the essence of a particular skill, regardless of how much content they know. However, it is also possible tc assess students' ability to *integrate* and *apply* thinking skills with specific content knowledge. For example, if students were asked to evaluate a proposed piece of legislation on seabed mining, they would need not only the kind of basic thinking skills assessed in the preceding examples, but reasonably sophisticated knowledge about seabed mining. Generally, we find that objective items are not the best means for assessing students' ability to make this kind of integrated application of knowledge and skill. Essays and similar product-related forms of assessment are more suited to this task, as will be discussed later.

Assuring Quality in Objective Items. It is beyond the scope of the handout to discuss principles of item-writing in detail. For information on technical principles to be followed when constructing various types of objective items, particularly multiple-choice items, refer to Bloom et al., 1981; Fiasca, n.d.; Fielding & Schalock, 1985; Hopkins & Antes, 1979; Mehrens & Lehmann, 1984. A few simple guidelines for preparing test items about social issues deserve mention. One is that care must be taken to assure that an item *does not contain clues* as to the correct answer. It's easy, for example, to fall into a pattern of making the correct answer longer than the "distractors" (the wrong answers), since correct answers tend to be more qualified, subtle, or elaborate than incorrect choices. But if correct answers are consistently longer than distractors, students might choose longer options simply because they are longer.

Another simple guideline is to check to be sure that *each distractor is plausible*. If a distractor is so obviously wrong that alert students would likely eliminate it even if they knew little about the problem defined by the item, the distractor should be replaced. (One way to tell if a distractor is too obviously wrong is to see how many students select it on a test. If a very small percentage of students choose it, then it probably should be considered ineffective.)

Finally, be sure that there is *only one answer* to response-selection items that experts would consider correct. For short-answer items, make sure the range of acceptable responses is limited. When time and circumstances permit, consider asking a colleague to review items to confirm that the correct or acceptable answers are in fact correct or acceptable.

Essays and Related Written Products

An essay is a written composition of at least one paragraph that expresses and supports an opinion on a social issue in science. Related to essays are written products such as a letter to an editor of a local newspaper on a science-related community issue, a written proposal for legislation on a public policy issue in science, or an imaginative story on the social impact of a particular technological innovation. Essays and related writing assignments give students a chance to integrate and apply what they have learned. They are more open-ended than short answers and often require divergent and creative thinking on the part of students. They also allow teachers to gain a fuller picture of students' thinking and valuing processes than do objective items.

Essays and other written products can be prepared in response to socially significant *scientific* issues, or to *value* and *action* issues. Writing dealing with scientific issues involves the objective application of scientific knowledge to a particular case. Writing dealing with value and action issues involves not only the reasoned application of knowledge, but the development of a personal point of view.

Writing in Response to Scientific Issues. Scientific issues often take the form of open-ended problems about the likely effects of a particular technological product or process on the natural or social environment, on human health or safety, or on personal lifestyle. These issues do not call for value judgments or proposals for actions, but for an impartial appraisal of a situation. Following is an example of an open-ended written exercise dealing with acid rain

Example:

Mary is going to hike into a lake in the Oregon Cascades. Fifteen years earlier, Mary had been to the same lake to conduct a study for the Oregon Fish and Wildlife Commission. At that time, the lake was a typical high mountain lake surrounded by coniferous trees on three sides and some alders, birches, and maples on the more level, meadow side of the lake. The lake had been a favorite fishing spot for her father and grandfather, producing many shrimp-fed rainbow trout. She learned that crawfish from the lake were good bait for the fish.

Describe the changes you think might have occurred in the plants and animals of this environment if acid rain had significantly affected the area. Make specific references to the assigned reading to support your hypotheses.

The following criteria will be used to evaluate your response:

1 point will be given if your response is clear and well organized.

1 point will be given if the response is logically supported by specific references to the background reading.

2 points will be given if the response shows "in-depth" thought; that is, a careful and thorough consideration of the possible effects that acid rain might have had on this environment.

Writing in Response to Value and Action Issues. Essays and similar student products are excellent vehicles for assessing students' ability to respond critically and creatively to value and action issues in science, and for determining what students have learned from discussions and debates. Below is an example of the way written tasks can be used for this purpose. Note that these tasks require more than predicting consequences or performing technical analysis. They require students to integrate knowledge, skills, and *personal beliefs* and *attitudes* in fashioning a response. Note also that the writing task is meant to be done in stages, over time, with opportunity for feedback from the teacher before a final product is submitted. Complex essays and related products are probably best prepared under these conditions, rather than in a test situation.

Example:

We have read several articles during this unit on the problems caused by nonbiodegradable disposable diapers. Diapers of this type are often found in streams and rivers, on beaches, in parks, and at wayside stops along our highways. It appears that this kind of careless disposal of diapers runs the risk of contaminating water supplies and spreading disease. Disposable diapers are, however, a great convenience to many families.

Write a letter intended for the local newspaper that explains what you think both individuals and the government should do to deal with the problem of disposable diapers. Be specific! Give reasons to support your proposals for action.

Your letter will be evaluated according to how effective and workable your proposals are, and how consistent they are with the principles of ecology that we have studied. Also, the clarity and organization of the letter will count in your grade. (The specific "scale" I will use to score your letter is contained on the back of this page.)

A first draft of your letter is due in three days. I'll give you some feedback on this draft, with suggestions for improvement. The final draft, which will be graded, will be due two days after I return your first draft.

		RATINGS	
CONTENT (Characteristics or proposed solution)	**3**	**2**	**1**
EFFECTIVENESS	Contains convincing evidence that the solution will **produce the results desired**	Contains some evidence on effectiveness, but needs more	Contains little or no evidence on effectiveness, or irrelevant evidence
ENVIRONMENTAL IMPACT	Contains convincing evidence that the solution will **preserve the integrity of the environment**	Contains some evidence on environmental impact, but needs more	Contains little or no evidence on environmental impact, or irrelevant evidence
PRACTICALITY	Contains convincing evidence that the solution is **realistic and reasonably easy to implement**	Contains some evidence on practicality, but needs more	Contains little or no evidence on practicality, or irrelevant evidences
FORM			
ORGANIZATION	Clear and easy to follow	Generally clear, but some parts confusing	Jumbled
MECHANICS (Grammar, punctuation capitalization, spelling)	Consistently correct	Generally correct; occasional errors	Frequent errors

General Considerations in Developing Essay-Type Assessments. Through the illustrations shown above, we have suggested two key principles in constructing essay-type questions. One is that the question or assignment given to students ought to have *a clear focus*. It's tempting to ask very open-ended questions, such as "What should be done in your opinion about the problem of toxic wastes?" or "Is research on recombinant DNA good or bad?" Such broad, vague questions are difficult to respond to. Some limits need to be placed around a topic or assignment for students to know how to begin developing a response.

Another key guideline reflected in the examples is to establish *explicit standards* for evaluating essays or other products and communicate them to students before they begin writing. When students know how their work will be judged, they have a clear target. Also, when evaluation standards are communicated in advance, students tend to regard evaluation as fairer than when standards are known only to the teacher. Finally, establishing explicit evaluation standards is helpful to the teacher because it enables him or her to rate papers more consistently.

Attitude Questionnaires

This section focuses on the assessment of student attitudes. Fostering student attitudes with respect to social issues in science is as important as developing knowledge and skill in this area. Without positive attitudes, it is doubtful that students will continue to learn and act upon science-related issues outside of school.

Questionnaires can provide a relatively simple and efficient means of assessing student attitudes. Information from attitude questionnaires, although not relevant for grading, can be useful in evaluating the effects of instruction in the "affective domain" and for making instructional plans and improvements. In this section, we identify major categories of attitudes you might wish to assess through a questionnaire, illustrate different question formats, and provide some general guidelines for constructing questionnaires in this area.

What Might Be Assessed Through a Questionnaire. Four major categories of attitudes related to personal and social issues are the focus in this section. One concerns the degree to which students have *interest* in the study of social issues and participation in issue-related activities. For example, a teacher might want to determine the degree of importance students attach to studying, or keeping informed about, socially significant science problems, or the degree to which students have an interest in conveying their views on science issues to policy-makers or business or community leaders.

Another category of attitudes concerns student *confidence*. Do students believe that they are capable of understanding social problems related to science? Do students trust that their own opinions will be worthy of consideration? Do students have confidence that people will want to listen to their opinions, or that they can actually exert an influence on public decisions on science-related issues?

A third type of attitude that might be assessed through a questionnaire concerns student *preferences*. Do students prefer to learn about social issues through one type of activity versus another (lectures versus textbook assignments, labs versus films, discussions versus simulations, etc.)? Do they prefer to work alone or with others? Do they prefer to express their opinions on issues in writing or orally? Information on student preferences can be helpful in adapting instruction to individual students' learning styles.

Finally, attitude questionnaires also might focus on *habits and behaviors* that seem to express and reinforce positive, responsible attitudes toward science and its application. Here we refer to such behaviors as turning off faucets and unneeded lights, separating trash for recycling, picking up litter in parks and similar public settings, and so forth. The National Assessment of Educational Progress has in fact included items on a nationwide student survey that dealt with these types of habits and behaviors (NAEP 1979).

Question Formats. As was mentioned in regard to objective test items, a fundamental distinction in item formats is between response-selection and response-construction items. The former require students to choose an answer from a set of preestablished options. The latter ask students to create their own answers. Response-selection items on questionnaires often are referred to as "closed" items; response-construction items often are referred to as "open" items. Here are examples of closed and open items:

Example (closed item):

During each of the past three units, we have spent a couple of days studying a social problem related to science. Do you feel we should continue or stop studying science-related social problems? (Check the answer that best expresses your feelings.)

A. We *definitely* should *continue*

B. We *probably* should *continue*

C. I don't know

D. We *probably* should *stop*

E. We *definitely* should *stop*

Example (open item):

During each of the past three units, we have spent a couple of days studying a social problem related to science. Do you feel we should continue or stop studying science-related social problems? Why?

____

____

____

____

The obvious advantage of the closed form is that it is easier and less time-consuming for students to answer and for teachers to "score" and interpret. The advantage of the open form is that it permits students greater freedom in developing and expressing their feelings. It also may produce unanticipated types of responses.

One way to maintain some of the advantages of each item form is to use a mixed form. A mixed form presents a closed item, but then includes an open space for student comments. For example, after the closed item above, a space could be provided in which students are given the option of elaborating upon their response in a few sentences or a paragraph. Another common pattern is to use the closed format for the bulk of the items on a questionnaire, but then to include several open items toward the end of the instrument.

Specific Types of Closed Items. Four types of closed items are useful: (1) two-way measures, (2) category scales, (3) checklists, and (4) rank-order scales.

Two-Way Measures. This is perhaps the simplest type of closed item. It presents students with two alternatives, such as yes-no, approve-disapprove, more-less.

Example:

Did you participate in the "Clean Up the Park" campaign this spring?

____Yes _____No

Two-way items are appropriate when there are two clear-cut responses to a situation. As the example above suggests, questions about whether students engaged in particular behaviors that might indicate an interest in social issues of' ͐ can be written in a two-way form. However, two-way items permit no "gray area in students' responses. Nor do they allow any distinctions to be drawn in the intensity or strength of students' feeling or the frequency of their behavior. The use of this type of item in the area of social issues is therefore fairly limited.

Category Scales. In this format, a category of response to a statement or question is identified, such as the category of "agreement-disagreement." Various degrees of levels of response within the category are then established and translated into points on a scale, for example, a five-point scale, in which 1 might represent "Strongly Disagree" and 5 "Strongly Agree." A category scale permits students to indicate the intensity of their feelings about something. Here are two examples of category scales.

Example 1:

For me, keeping up with news about scientific discoveries and inventions is of:

A. no importance
B. little importance
C. somr importance
D. considerable importance
E. great importance
F. I don't know

Example 2:

If an energy company proposed a plan for building a nuclear power plant in our area, I would attend a public meeting to find out more about the plan.

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	2	3	4	5

Category scales are relatively easy to design. Students themselves, through informal class discussion or casual comments, often supply statements that can be used when constructing category scales. For example, students sometimes say things like: "You can't really do anything about these social problems we've been studying, so why do we bother writing about what we would do to solve them? Anyway, who cares what we think about these things." To get a sense of how widespread such attitudes are, you could develop an item using essentially students' own language and feelings as a stem.

Category scales can be used to assess a range of attitudes and feelings and to determine whether changes in attitudes have taken place over a period of time. They are probably the most widely used type of item on classroom attitude questionnaires.

Checklists. A checklist presents students with a series of statements or other response options that relate to a particular topic. Students are asked to check the response or responses that apply to them. Checklists are good ways for students to indicate actions or behaviors they have carried out, or plan on carrying out, related to social aspects of science.

Example:

During the past three weeks, did you (Check each space that applies):

_____ talk with a friend, family member, or neighbor about any of the science-related social problems we've been studying in class?

_____ read a newspaper report or magazine article that dealt with a scientific topic?

_____ watch the television documentary on genetic engineering broadcast by PBS?

_____ visit the special exhibit on laser technology at the Wesley Museum of Science?

_____ do other things outside of class related to science? If you check this space, describe the things you've done:

____

____

____

____

As the example above suggests, checklists can point out things to students that they might not think or remember to say if asked a purely open-ended question.

Rank-Order Scales. Rank-order scales ask students to place each item in a series along some type of continuum, for example, from most frequent to least frequent, from most valuable to least valuable, or from most preferable to least preferable.

Example:

From which of the following types of class activities do you feel you have learned the most? Put a "1" next to the activity you feel you have learned the most from, a "2" next to the one you have learned the second most from, and so forth If you don't feel that you have learned more from one type of activity than another, check the last space.

_____ Lectures

_____ Laboratory activities

_____ Discussions

_____ Computer simulations

_____ None of the above has been more or less of a help in learning than the others

Rank-order scales are useful in that they allow students to compare feelings toward one thing with feeling towards another, or their interests in engaging in one type of activity versus another.

General Guidelines for Designing Attitude Questionnaires. Several guidelines for constructing attitude questionnaires are presented in the following paragraphs. More detailed information on this topic can be found in books by Fink and Kosecoff (1985); Henerson, Morris, and Fitz-Gibbon (1978); and Mehrens and Lehmann (1984).

One suggestion for writing questions is to *make them concrete.* A question like "How interested are you in keeping informed about science-related community issues?" probably would be too abstract and vague for most students to respond to. A more concrete item addressing this subject might look something like the example below.

Example:

We've been reading articles from the local newspaper on land-use questions that our community faces. If articles on land-use questions appeared in the newspaper in the future, would you read them on your own

1. No, definitely not
2. Probably not
3. I don't know
4. Probably
5. Yes, definitely

Another suggestion is to focus each item on a *single idea*. If a question deals with more than one idea, it is difficult for students to respond to and for teachers to interpret. For example, consider the following "double-barreled" item: Indicate your degree of agreement-disagreement with this statement: "I like science class because we get to do laboratory activities." (1 = Strongly Agree; 5 = Strongly Disagree). It would be better to ask first about students' feelings towards science class, and then, for those who indicate positive feelings, ask other questions about the reasons why.

A third suggestion is to avoid asking questions that all or almost all students are likely to give the *same response* to. The following statement, for example, might elicit the same response among classmembers: "Which do you prefer to do: watch TV or study science?" Items on a questionnaire, like items on achievement tests, aren't much good if they fail to differentiate among students. Try to construct items that will reveal differences among students.

A fourth suggestion is to consider asking several questions that relate to the *same attitude*. Including different questions dealing with the same underlying attitude can help assure that you are assessing what you really want to assess. For example, if you asked three questions about students' interests in scientific topics, and students responded in a similar manner to each, you probably would have more confidence in the conclusions you reached about students' interests than if you asked just one question.

Finally, we would emphasize the importance of assuring students that results from attitude questionnaires have nothing to do with their *grades*. To reinforce this point, you might want to ask students to respond anonymously to questionnaires. Students need to know that they can respond honestly to questionnaires without risking any negative consequences for doing so.

Classroom Observations

Procedures for observing students' use of particular skills, processes, or behaviors are a valuable part of a teacher's assessment repertoire. Observations of discussion skills, cooperative problem-solving processes, and behaviors that show responsible attitudes toward technology and its uses (using lab equipment properly and safely; using recycled paper, when feasible; picking up litter, etc.) are important sources of information when planning and improving instruction in the area of social issues.

Compared to objective test items, essays and questionnaires, observations can be difficult to structure and interpret. The other forms of assessment involve each student's producing a tangible response or product (an answer sheet, written document, or completed form) that can be examined, and re-examined, when the teacher has time. When using observational procedures, the teacher must actually see what is being assessed *as it is occurring* (unless, of course, a videotape is made of student behavior; this possibility is discussed later). In a class of 30 students, it is, needless to say, difficult to observe each student as carefully and fully as one might wish.

Because of the practical difficulties of conducting systematic and complete observations of each student's performance and behavior, we recommend that effort be made to prepare students to *observe each other's skills.*

We also recommend that, when appropriate, observations focus on the behavior of a group *as a whole,* rather than on individuals. When assessing group communication, cooperation, or problem-solving skills, for example, it generally is best to observe how a group behaves as a unit. For example, you, or students who are trained as "process observers," might sit outside a group and use a checklist, such as the one shown below, to identify whether the group is carrying out key functions, such as establishing clear goals and achieving effective compromises. In this context, the focus would be on the group's effectiveness, not on a particular individual's skills.

Example (observational checklist):

	Yes	No	Can't tell	Comments
1. Group members check to make sure everybody is clear about what the group is trying to accomplish.	____	____	____	________
2. Each group member participates.	____	____	____	________
3. Group members engage in constructive give-and-take.	____	____	____	________
4. The group sticks to its task.	____	____	____	________
5. The group works without interfering with other groups.	____	____	____	________
6. The group checks its progress toward accomplishing its goals and modifies its processes, if needed.	____	____	____	________
7. The group records and summarizes what it has accomplished.	____	____	____	________

We suggest, furthermore, that you *consider videotaping* some of the situations (class discussions, small-group problem-solving sessions, etc.) you or your students are observing and discuss the tape with the class. If this is too embarrassing or threatening for students, you may wish to use tapes of pertinent situations made elsewhere—for example, in a class taught by a colleague in another school. Showing tapes of such situations enables you to identify and discuss with the class concrete examples of the skills or processes you want to develop.

We recognize that students having difficulty in discussions, simulations, field activities, or other situations might require focused and sustained classroom observations in order to pinpoint behavior or performance problems or to document that improvements in behavior/performance are being made. In such cases, *anecdotal records* (written notes recording specific, significant incidents of student behavior—either undesirable or desirable) might be maintained, or the teacher might want to personally observe a student's participation patterns in group discussions or projects, using structured checklists or rating scales.

Finally, we emphasize the care that must be taken if a teacher wants to use observations for purposes of *grading*. We recommend that this be done only if and when observations are planned and carried out in a highly systematic manner, so that students know just what skills are to be observed, the conditions under which the observations are to be carried out, and the standards to be used when evaluating information obtained through the observations.

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APPENDIX A: TRANSPARENCY MASTERS

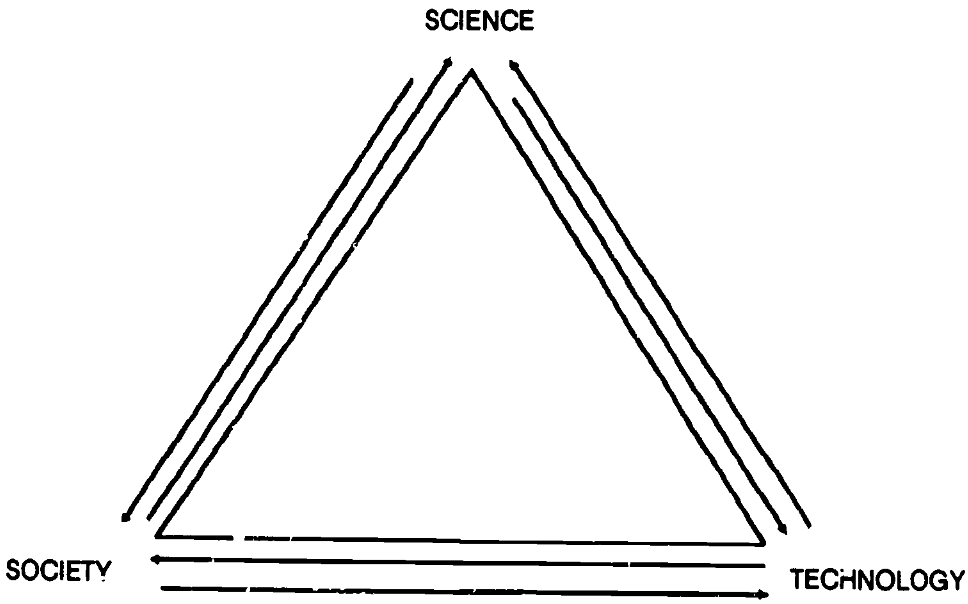
The materials provided here are used in several of the training activities in this volume. Because some contain considerable text, you may find them more suitable for use as handouts than transparencies, although use of transparencies will reduce the copying requirements. The ultimate decision of how to use these materials rests with the individual trainer

SCIENCE/TECHNOLOGY/SOCIETY

Science—A systematic, objective, empirical approach to asking questions and looking for answers.

Technology—The application of knowledge to the solution of practical problems.

Society—The collective interactions of human beings at local, national, and global levels.



A RATIONALE FOR STS EDUCATION

One can neither perceive contemporary events accurately, nor think effectively about them, nor act responsibly as a citizen in a modern democracy without learning about science and technology as powerful cultural forces.

Modern societies, such as the United States, are increasingly propelled and changed by advances in science and technology—distinct and synergistic ways of knowing about and altering the world. Sciences (processes of knowing about nature and society) and technologies (ways of using knowledge to satisfy human needs or wants) are combined in modern societies to provide increasing human control over natural and social environments. Tremendous, ongoing achievements have spawned great hopes, fears, and controversies associated with a plethora of developments (e.g., nuclear power, genetic engineering, organ transplantation, robotics, pesticides).

In a democracy, citizens have the right and responsibility—as voters, consumers, workers, and officeholders—to participate in decisions about issues related to social uses of science and technology. The success of individuals and their society is tied to the quality of these choices, which varies with the knowledge and cognitive skills of decision makers. The vitality of our American democracy depends upon widespread ability of citizens to think effectively about developments in science and technology and their effects on the world. Therefore, a central mission of American schools should be education on science and technology in a social context. This kind of general education for citizenship is likely to help students from all social groups understand more fully their own civilization and its connections to the world, to think more effectively, to act more productively, and to participate more responsibly in the democratic process.

KNOWLEDGE, SKILLS, AND ATTITUDES IN STS

A. Goals	**1. Acquisition of Knowledge**	**2. Utilization of Cognitive Process Skills**	**3. Development of Values and Attitudes**
	Related to Science/ Technology/Society	Based on Inquiries in Science/Technology/ Society	About Practice of Science and Technology and Democracy
B. Means	Through Study of Content in Three Areas of Emphasis	By Means of Three Types of Intellectual Activity	As an Outcome of Educational Experiences That Emphasize Two Kinds of Affective Orientations
C. Content and Activities	STS Interactions Concepts/Topics STS Issues	Processing Information Problem Solving Making Civic Decisions	Values in Processes of Science Values in Democracy

STS ISSUES

Population Growth
(world population, immigration, carrying capacity, foresight capability)

Water Resources
(waste disposal, estuaries, supply, distribution, ground water contamination, fertilizer contamination)

World Hunger and Food Resources
(food production, agriculture, cropland conservation)

Air Quality and Atmosphere
(acid rain, CO2, depletion of ozone, global warming)

War Technology
(nerve gas, nuclear developments, nuclear arms threat)

Energy Shortages
(synthetic fuels, solar power, fossil fuels, conservation, oil production)

Land Use
(soil erosion, reclamation, urban development, wildlife habitat loss, deforestation, desertification, salinization)

Human Health and Disease
(infectious and noninfectious disease, stress, noise, diet and nutrition, exercise, mental health)

Hazardous Substances
(waste dumps, toxic chemicals, lead paints)

Extinction of Plants and Animals
(reducing genetic diversity, wildlife protection)

Nuclear Reactors
(Nuclear waste management, breeder reactors, cost of construction, safety, terrorism)

Mineral Resources
(nonfuel minerals, metallic and nonmetallic minerals, mining, technology, low-grade deposits, recycling, reuse)

UNIFYING CONCEPTS FOR SCIENCE, TECHNOLOGY, AND SOCIETY

CONCEPTS	DEFINITIONS
SYSTEMS AND SUBSYSTEMS	A system is a group of related objects that form a whole or a collection of materials isolated for the purpose of study. Subsystems are systems contained entirely within another system.
ORGANIZATION AND IDENTITY	Systems have identifiable properties. There are boundaries, components, flow of resources, feedback, and open and closed aspects of systems organization. Changes in properties may cause a change in the system's identity.
HIERARCHY AND DIVERSITY	Matter, whether nonliving or living, is organized in hierarchical patterns and systems. Hierarchical levels of organization range from subatomic to cosmic. There is increasing complexity of organization within physical, biological, and social systems. Diversity can increase the stability of systems.
INTERACTION AND CHANGE	Components within systems interact, and the systems interact with each other. There is usually evidence of the interaction. Evidence of interaction provides opportunities for identification and analysis of causal relationships. All things change over time. The course of change may be influenced to modify the properties, organization, and identity of systems.
GROWTH AND CYCLES	Linear growth occurs by a constant amount over a time interval. Exponential growth occurs by an increasing rate (at a constant percentage) over a time interval. Some systems change in cycles.
PATTERNS AND PROCESSES	Interactions, change, growth, and cycles often occur in observable patterns and as a result of identifiable processes.

CONCEPTS	DEFINITIONS
PROBABILITY AND PREDICTION	Some changes are more predictable than others. Statistical calculations provide some degree of accuracy (a probability) in the prediction of future events.
CONSERVATION AND DEGRADATION	Matter and energy are neither created nor destroyed. Both may be changed to different forms. This is the first law of thermodynamics. Considered as a whole, any system will tend toward increasing disorder. This is the second law of thermodynamics.
ADAPTATION AND LIMITATION	All systems respond to environmental or cultural challenges. There are limits to environmental, organismic, and social changes. Adaptations may be biological, physical, technological, social, political, or economic.
EQUILIBRIUM AND SUSTAINABILITY	Equilibrium occurs when components of a system interact in ways that maintain a balance. Due to adaptation, growth, and change, all systems exist on a continuum from balanced to unbalanced. The extent of the equilibrium or disequilibrium is a function of the system's capacity to carry the load created by factors operating in and on the system. A social system is sustainable if its organization results in stability of its natural resources and environment.

COGNITIVE PROCESS SKILLS FOR STS

SKILLS	DEFINITIONS
Processing Information	
QUESTIONING AND SEARCHING	Curiosity and questions about the world are basic to inquiry skills. Thus, locating or discovering information based on questions is essential. Informal inquiry – questioning and searching – are first steps toward scientific and technologic problem solving and personal and social decision making.
OBSERVING AND ORGANIZING	One or more senses are used to gather information about objects, events, or ideas. Once observed and gathered, information must be grouped in relation to space, time, and causal relationships.
MEASURING AND CLASSIFYING	Elements of these skills are counting objects or events, establishing one-to-one correspondence, and organizing objects according to numerical properties; quantifying descriptions (e.g., length, width, duration) of objects, systems, and events in space and time; forming meaningful groupings; putting objects or events in order by using a pattern or property to construct a series (seriation). Classifying includes defining similarities and identifying subsystems based on a property and arranging subsystems and systems in a hierarchy.
COMPARING AND CONSERVING	Comparing involves identifying similarities, differences, and changes in objects and systems in space (local to global) and time (past, present, future). Conserving involves understanding that quantitative relationships between materials and systems remain the same even though they have undergone perceptual alterations.
ANALYZING AND SYNTHESIZING	Information is reduced to simpler elements for better understanding of the organization and dynamics of objects, systems, events, and ideas. Analysis includes describing components, clarifying relationships among systems or subsystems, and identifying organizational principles of systems. Where analysis stresses reduction and parts, synthesis stresses construction and the whole: bringing together information to form unique organizations, patterns, or systems. Understanding that the whole is greater than the sum of parts is part of synthesis.

Problem Solving

IDENTIFYING AND DESCRIBING

These skills extend those of gathering information to problem solving. Problem identification and description are first steps in formal inquiry. Included are identification of personal and/or social problems, gathering information, and describing what is known and unknown about a problem.

HYPOTHESIZING AND PREDICTING

When confronting a problem, one must make reasonable guesses or estimates based on information. Included are making statements of conditionality – "if...then..." – concerning a problem and predicting possible conclusions. Inductive (specific to general) and deductive (general to specific) thinking as well as propositional thinking are included.

SEPARATING AND CONTROLLING

Applying logical patterns of reasoning – whether to the design of formal experiments, analysis of data, solution of problems, or evaluation of policies – is based on the skill of separating and controlling variables. Making clear how a condition or event is similar to or different from other conditions or events is part of this skill, as is identifying factors and all possible combinations of factors relative to a problem. Factors must be controlled and one variable changed to determine how it influences reactions. Hierarchical thinking is used in such tasks as building classification keys.

Decision Making

EXPLORING AND EVALUATING

Describing the decision to be made, using skills developed earlier to identify and gather information, converting information to alternatives, and examining the consequences of different decisions are all part of the exploration of a decision. Evaluating consists of making value judgments based on the internal consistency of information and clearly defined external criteria such as costs, risks, and benefits of alternatives.

DECIDING AND ACTING

Deciding involves selecting from among alternatives to make an intelligent and responsible choice. Available information is used to justify the decision. Ways and means of taking responsible action are identified to reduce or eliminate problems.

VALUES AND ATTITUDES FOR STS

Values/Attitudes	Explanation
VALUES, ATTITUDES, AND ASSUMPTIONS ABOUT KNOWLEDGE	
Methods of inquiry in science are embedded in a network of values, attitudes, and assumptions (statements accepted as true without proof) and knowledge—what it is and how it is produced.	1. Knowledge is never complete and humans should engage in the quest for it. The forms and sources of human knowledge have limits. There are always more questions than answers, and the body of knowledge on any topic is never adequate. Furthermore, seeking and producing knowledge are worthy human endeavors.
	2. Knowledge changes over time, as does the structure of knowledge. This distinction is as subtle as it is significant. Obviously, the information we possess on a topic changes as more is learned. But it is also true that the way that information is processed, organized, and evaluated changes. Facts thought unimportant at one time may prove central to the scientific enterprise at some other time.
	3. The physical world can and should be known through the processes of scientific inquiry. Scientists believe that the physical world exists independently of human perceptions, that it can be known through objective, empirical investigation, and that acquiring this knowledge is worthwhile.
	4. The physical world operates under a set of laws that are constant, thereby permitting prediction. Scientists assume that the laws governing objects and phenomena are the same across time and space.
	5. Phenomena should be described and explained in mechanistic terms without using supernatural interventions. Whether supernatural forces may be at work is unknown and unknowable to the scientist. The scientist looks not for purpose of deliberate design, but for the character and function of objects or phenomena as they exist now or as they have existed in the past.
	6. Every cause has at least one effect and every effect has at least one cause. The aim of science is to develop necessary and sufficient explanations for natural phenomena; while this goal is not achieved, it nevertheless serves as an ideal. Researchers attempt to sort the range of causes and to assign relative weights to specific

variables within a large set. Though more complicated in expression, the fundamental principle of cause and effect is still at work.

7. Data do not necessarily speak for themselves. A single body of data may logically support more than one conclusion, just as different bodies of data may support a single interpretation. Inferences from data are made by humans and are, therefore, fallible constructions. Conclusions must be viewed as tentative and subject to refutation. Thus, responsible skepticism and criticism are continuing activities within the natural and social sciences.

8 If observations are valid, they are replicable. Single-source, one-time reports are insufficient evidence. Replication is an essential activity in both the natural and social sciences.

9. Scientific explanations have an aesthetic quality. This is the "elegance" of experiments, hypotheses, and theories. When the parts of an intellectual puzzle fall neatly into place, the result has beauty.

10. Knowledge is more likely to approach the ideal of truth when obtained objectively. Data obtained from controlled experimentation have greater validity than opinion, conjecture, and even judgment based on experience. Thus, objectivity is valued in the pursuit and production of knowledge.

VALUES, ATTITUDES, AND ASSUMPTIONS ABOUT PERSONS ENGAGED IN SCIENTIFIC INQUIRY

Characteristics of persons engaged in scientific inquiry are linked to values, attitudes, and assumptions involved in the heuristics of science.

1. There is value in diversity of ideas and a commitment to remaining open-minded in confronting competing ideas. Science requires its practitioners to sift through alternative hypotheses, all of which must be assumed plausible until empirically refuted. Science grows through the testing and accepting or rejecting of competing ideas.

2. Knowledge is good. Science – by definition a search for answers to questions – rejects the maxim that ignorance is a satisfactory state of affairs. The scientifically-minded prefer empirical knowledge as explanations for objects, events, and phenomena in the physical and human environment.

3. Curiosity is essential to scientific progress. Science is the enterprise of the curious. We assume that science continues with a vigor roughly proportionate to the curiosity of its practitioners.

4. Prudence resides in the tendency to defer judgment until the facts are available and can be assessed rationally. Like other people, natural and social scientists must make decisions in the face of incomplete data, but the scientifically-minded person is prone to seek out relevant facts, consider options, and postpone judgment until data are analyzed.

5. Logic is an essential attribute. The resolution of problems through logical approaches is central to the methods of science. This is not to ignore the often-critical place of intuition and creativity in arriving at new procedures or answers. The test of new knowledge lies, however, in the appeal to data and logic in the construction of new theories.

6. Patience and perseverance are important qualities for scientific research. The scientifically-minded believe that there is value in sticking with a task, even when conventional wisdom might suggest a gallant retreat. Perseverance also means dedication to an idea or an ideal and a high level of tolerance for the monotony and frustration of continued long-term investigation.

7. Error may be honorable in the honest search for knowledge and applications. Criticisms from other scientists and refutation of assertions are part of the process of science. Sometimes scientists defend their ideas beyond the reasonable canons of scientific inquiry, but the value of "honor in error" is a goal, even if one not too often achieved.

VALUES, ATTITUDES, AND ASSUMPTIONS ABOUT CITIZENSHIP IN A FREE SOCIETY

Values and attitudes in science are compatible with civic values in a free society. Progress in science depends upon open communication, free speech and press, freedom of assembly, and academic freedom, which are basic values of the American constitutional democracy.

1. Civil liberties and rights of individuals are protected by law and the U.S. Constitution. A basic value of a democracy is freedom to think and express ideas, even if they are unusual, unpopular, or critical of prevailing practices and beliefs. Freedom to think, examine, and express ideas is, of course, critically important to the vibrant exercise of scientific inquiry.

2. Social pluralism and diversity are accepted and encouraged within reasonable limits. A free

society is open to variation in thinking and acting, so long as this does not undermine or threaten to destroy social unity or the common good. An open society – tolerant of diversity – encourages innovation and progress in science, because science depends upon open communication and free movement of people and ideas within and across cultures.

3. Citizens have freedom and responsibility to participate in policy decisions. Experts, such as scientists, are called upon to inform citizens and policy makers, but the limits of scientific expertise are recognized. Policy decisions are made in terms of values, which are outside the boundaries of scientific expertise. As a participant in policy decision making, the scientist plays the role of citizen in concert with other citizens. Thus, in a democratic society, the power and limits of science are recognized in civic decision making and governance.

4. Equality of opportunity and rewards based on merit, not special privilege, are main characteristics of a free society. Individuals are encouraged and assisted in developing their talents to the fullest and are enabled to achieve rewards commensurate with contributions to the society. These values and attitudes about opportunity and rewards, if operational in a society, are likely to stimulate maximum development and use of talent in science and technology, as well as other fields of work.

5. The dignity and worth of the individual, as a responsible member of society, is a fundamental premise of a modern democracy. In a democracy, the society is organized to reflect the popular will through majority rule. In a modern constitutional democracy, however, the rights of individuals and minority groups must always be respected within a framework of concern for the common good, as expressed by majorities. The social uses of science/technology in a democratic society must therefore reflect majority rule with protection of minority rights and the dignity and worth of individuals. Civic decision making about science/technology-related social issues should combine concern for individuals and their communities.

GUIDELINES FOR EDUCATION ON KNOWLEDGE IN STS

1. Develop understanding of three concepts—science, technology, society—and the interrelationships among these three concepts.

2. Emphasize knowledge of major concepts in science and technology that are associated with significant social changes and scientific issues; these concepts should be applicable to social changes and scientific issues of continuing importance to citizenship in a free society.

3. Emphasize knowledge of major concepts and topics in history and the social sciences that are associated with significant social changes and scientific issues; these concepts and topics include institutions and activities connected with the practices, products, and effects of science/technology. These concepts and topics should be treated in historical perspective and with futuristic vision.

4. Teach about STS issues in history and contemporary society that help students understand STS interactions; these STS issues should be linked to core concepts and topics of standard secondary school subjects in the sciences and social studies.

5. Develop understanding of the uses, limits, abuses, and consequences of scientific and technological work; the ultimate goal is connecting education about science/technology/society to development of good citizenship in a free society.

GUIDELINES FOR EDUCATION ON COGNITIVE PROCESS SKILLS IN STS

1. Emphasize development of the skills involved in scientific/technological inquiry—including information processing and problem solving—as ways of producing and applying knowledge about nature and society.

2. Emphasize development of the skills involved in civic decision making as a rational means of assessing, judging, and resolving issues about the uses of science and technology in society.

3. Provide continual practice to direct students' use of cognitive process skills and to correct mistakes immediately and constructively.

4. Use direct teaching as a useful means to introduce skills. Stimulate and guide students to think on their own, to resolve dilemmas, to take stands on issues, and to judge propositions about knowledge.

5. Emphasize practice of skills as part of a process, such as civic decision making or problem solving in scientific inquiry. Avoid teaching skills separately.

6. Incorporate learning activities on cognitive process skills in the core curriculum—school subjects required of all students. Thinking skills in science/technology/society should be developed systematically and extensively in all social studies and science courses, in a manner consistent with the intellectual development and prior learning experiences of students.

APPENDIX B: TEACHING STRATEGIES FOR STS

The substance of education on science/technology/society demands the use of a range of teaching strategies—strategies that actively involve students in their learning, that help them analyze controversial and value-laden issues, that allow them to examine various viewpoints and develop their own. While lecture/reading and discussion may be useful in examining STS issues, other techniques are needed to achieve the goals of STS education.

This appendix provides guidelines for two "problems" that may arise in teaching about STS topics: analyzing controversial issues and dealing with ethical issues. It then provides guidance related to a number of instructional strategies: using outside resource people, field experiences, role plays, simulations, case study analysis, brainstorming, and others.

For each strategy, the appendix provides background for the trainer, a list of potential uses of the strategy in STS, reference to lessons in the *Model Lessons* volumes that employ the strategy, and teacher information about the strategy for use as a handout. The referenced model lessons could be demonstrated in training sessions if time permits.

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ANALYZING CONTROVERSIAL ISSUES

Many STS issues simply cannot be examined without provoking some controversy. Consequently, STS teachers need to develop procedures or guidelines for dealing with controversy when it arises. The list provided on Handout B-1 can serve as a starting point for development of a set of such guidelines.

STS teachers who have not previously taught controversial issues will need to be convinced that doing so will have payoffs. Indeed, teaching about controversial issues has benefits for teachers, students, and the society at large. Teachers are always looking for activities that will motivate students to learn, and studies have shown that controversial issues do just that. Discussing controversial issues has been shown to motivate students in both reading and research tasks. In addition, skill in dealing with conflict over issues will minimize the problems that usually accompany "uninvited" controversies into the classroom.

For students, the benefits are many. First, dealing with controversial issues allows students to apply what they have learned to an issue that has relevance to their everyday lives. Studies indicate that the result is enhancement of a range of intellectual skills. Learning methods for dealing with conflicting opinions is also a skill that students will need as adults, so classroom exercises will provide much-needed practice. Students will also learn about themselves as they work through the value conflicts that are inherent in a controversy.

Research indicates that dealing with controversial issues increases students' feelings of efficacy in dealing with issues of public policy. Educators have hypothesized that such increased feelings of efficacy will counteract apathy and lack of civic participation. In addition, work in the area of delinquency prevention suggests that learning to deal with controversial issues promotes attachment to school and teacher and thus may contribute to reductions in delinquent behavior. While more research is needed in this area, instructional use of controversy clearly holds a great deal of promise.

Faith Hickman has suggested that the following assumptions be made when dealing with controversial STS issues:

1. The teacher operates as a manager who manages people, material resources, learning environments, and time.

2. Small-group discussion is used as the dominant mode of instruction. Small-group work has these advantages: (a) it encourages participation from students who might not otherwise participate; (b) it employs student's natural strengths as leaders and creative thinkers; (c) it frees the teacher to assist students on a personal basis, engage in conversations with individual groups, clarify issues, raise questions, and influence the direction of inquiry toward useful sources of information.

3. Controversy is used as a motivational force for substantive learning.

4. Sufficient factual information is brought into the discussion to avoid having students merely exchange opinions founded in ignorance.

Roger and David Johnson have developed a model for dealing with controversy in a positive way. The model involves the following steps:

1. Dividing the class into heterogeneous groups of four, with each student assigned a partner. The teacher should provide instructions on the use of the structured controversy model, stressing that the ultimate goal is writing a group consensus report.

2. Assign positions to pairs of students. The pairs of students should be given supporting material to study. Each pair chooses arguments that support their position and prepares a brief overview for the other pair.

3. The pairs present their positions to one another. These two- to three-minute resentations should include a description of the position and some of the supporting material.

4. The pairs engage in discussion, with each pair arguing in favor of its position. Substantiating data can be presented, and each pair can request data from the other pair. Students are to listen carefully to arguments, taking notes that can be used for the reversal.

5. Reverse the assigned roles. Each pair now has the opposite point of view and offers a brief (perhaps five-minute argument) using notes from the first round of arguments rather than the prepared materials. This brief role reversal encourages good listening.

6. Finally, groups choose a consensus position and write a joint report after the group has met to decide on a solution.

During this process, it is the teacher's role to encourage appropriate behavior and monitor students' progress. The teacher may need to intervene to give suggestions to individuals to help improve their progress. Teachers may choose to take a more active role in the process by:

- Presenting contrasting viewpoints.
- Playing "devil's advocate."
- Assisting one pair and then assisting their opponents.
- Reminding students to challenge each other.

Through this process, students gain understanding of the issues, improve their collaborative skills, and learn to deal with conflict. These skills will then ready the students to deal with controversy when it arises.

GUIDELINES FOR DEALING WITH CONTROVERSIAL ISSUES

In presenting controversial issues for discussion in your classroom, the following guidelines will be helpful:

- Lead students to expect controversy in your classroom, but prepare them for it as well. Discuss what a controversial issue is and establish rules for dealing with one. These rules might include such items as (1) everyone who has something to say will have a chance to say it, (2) ideas, not people, will be argued, (3) terms will be defined and slogans will be avoided, (4) sources of information will be cited, and (5) students will listen to their classmates' opinions.
- When a controversial issue is introduced or arises, identify it and make the nature of the disagreement clear, identifying areas of agreement or disagreement.
- Be willing to accept that not all issues can be resolved.
- Respect students' right not to express their opinions when personal values are being discussed. Some issues may strike too close to home; others may be difficult for some students to discuss for other reasons.
- Establish devices for maintaining group relations in the face of disagreement. Students should learn that disagreeing with a friend does not mean that the friendship must end. If students are able, guide them in developing the rules of behavior that will ensure continuing interpersonal harmony. One mechanism for maintaining harmony might be to end each discussion of a controversial issue with a class evaluation of how well students listened to each other and presented the evidence of their own views.
- Establish some means of closure; as the teacher, you will have to decide when agreeing to disagree is appropriate and when it is not.
- From time to time, encourage students to reconsider issues they have discussed previously to determine whether their opinions have changed over time.
- Be careful about expressing your own opinions, as they can affect students' analysis of the issue.
- Use as many instructional techniques as possible in dealing with controversial issues. All strategies should be used in support of students' working through a series of steps: identifying the issue, identifying alternatives, identifying the consequences or implications of each alternative, choosing an alternative, and—if appropriate—working toward group consensus and taking action. In working through this series of steps, students can be involved in a range of activities; role plays, simulations, and case study analysis are especially effective because they encourage students to both empathize with others and suspend judgment. In-depth study of one or more issues can also be effective.

In selecting issues for in-depth analysis, several factors should be considered. These include:

- Is there time to work through each phase of the analysis of this issue?
- Is this issue of interest to the students?
- Is this issue beyond the maturity and experiential level of the students?
- Is this issue socially significant and timely for this course and grade level?
- Is this issue one that you as the teacher feel you can handle successfully from a personal standpoint?
- Is this issue one for which adequate study materials can be obtained?
- Is this issue one that will clash with community customs and attitudes?

If you answer all of these questions and still have doubts, consult your principal or department chair. Remember, issues where there is disagreement over alternatives are numerous; if one issue is too complex, "hot," or sophisticated for your class or community, several more are bound to be suitable.

In dealing with some issues, reaching consensus will clearly not be possible. With others, working toward consensus will add another dimension to the study, demonstrating how conflict is resolved in a democracy. The teacher's role in this process is helping students discover common viewpoints and values they can accept, working from there to identify modifications of their positions that account for these shared values.

When feasible, student action on behalf of position can also be a valuable part of the learning process. Such action might include writing letters to the newspaper or to public officials, conducting a school forum on the topic, or presenting a petition to the local government.

ANALYZING ETHICAL ISSUES*

Ethical problems arise when values – the strongly held standards of worth by which we make judgments – conflict, and the socially responsible resolution to an issue or problem is not clear. Decisions about STS issues reflect the values of the decision makers; many decisions involve value conflicts. Thus, students need to be able to identify values and analyze how values affect decisions.

In discussing policy issues, people get involved in subissues related to the general policy issue. The subissues can be classified into three categories: (1) ethical or value issues, (2) issues of definition, and (3) issues involving facts and explanations. Distinguishing among these kinds of issues is an important first step in analyzing how values affect decisions. Ethical or value statements suggest that some object, person, or action has or lacks worth based on a general moral principle. Definitional issues revolve around the way important words or phrases are used in discussion. Factual issues are disagreements about the descriptions or explanations of events.

It is important for students, in discussing policy issues, to recognize value statements when others use them or when they use such statements themselves. Teachers may find Handout B-2 helpful in introducing the notion of value statements to students. It is equally important to recognize discussion situations in which a value statement can be challenged. Here are several strategies by which value statements can be supported or challenged:

- Use of value-laden language. Ethical or value statements can normally be phrased in "loaded" words that give rise to strong personal feelings. The use of value-laden terms is a shorthand way of reminding people that they have important value commitments.
- Use of a respected or venerable source. Value statements may be justified by showing that they are supported by a source that most people consider sacred, respected, or venerable: the Bible, the Constitution, the Declaration of Independence, and so on.
- Prediction of a valued consequence. Policy positions and value judgments are often used together to show that support of a particular policy will lead to a good end. When a policy position is linked to a valued consequence, there is the additional problem of showing that the valued consequence will, in fact, occur. Discussants may disagree about a valued consequence. They may then have to resolve a moral-value issue (which consequences are good?) and issues of fact (which consequences will actually occur?).
- Finding important values that conflict. Policy positions are commonly supported by a value statement, but this often does not settle the issue because in most public issues, we find principles that conflict with one another. For example, the value of full employment may be in conflict with the value of environmental protection.
- Use of empathic appeal. Another way of supporting a policy stand is to link it with the personal preferences or feelings of another discussant; this might be termed the "How would you feel?" approach. This approach has a serious shortcoming. Although we may feel sorry for individuals (for a person injured in an industrial accident, for example), involving our sympathy is not enough to persuade us to adopt policies that the troubled person may prefer.

Students cannot be expected to deal with values issues in this manner without a great deal of practice identifying and discussing values issues. The STS curriculum will certainly provide the opportunity for such practice. It should be noted that since public discussion of many important STS issues has occurred, analysis of values issues need not involve students' revealing their own values. Students can learn and practice the skills of values analysis by examining the values revealed in public discussions.

Adapted from Donald Oliver and Fred Newmann, *Taking a Stand* (Middletown, CT: AEP, 1967). Used by permission of the authors.

ANALYZING ETHICAL ISSUES

A first step in analyzing ethical issues is identifying the values in conflict. Lists such as those below may be useful in helping students begin this process. It should be noted that the lists are far from comprehensive, but discussing and defining these values will give students practice that will enable them to begin identifying other values as well.

Democratic Values

Authority

Diversity

Equality

Justice

Liberty

Life

Loyalty

Privacy

Promise-keeping

Property

Responsibility

Truth

Scientific Values

Knowledge

Diversity

Deferring judgment

Logic

Perserverance

Quest for knowledge

Reproducibility of results

BRAINSTORMING

Background Notes

Brainstorming is the process of generating as many alternative suggestions as possible to fit a given situation. The brainstorm is a useful classroom strategy because all students, regardless of level of academic achievement, can participate equally. It is nonthreatening because no evaluation is allowed, and it does not require prior preparation. In addition, a significant amount of information can be gathered quickly.

A critical concern, of course, has to do with what one chooses to have a class brainstorm about. The question should be clearly stated. It should be one for which there are multiple possible answers. Students should be able to generate ideas without extensive background knowledge.

There are specific rules for the brainstorming process (see Handout B-3), which should be shared and discussed with students before a brainstorming sessions begins. Allow students to call out their ideas without having to be recognized. All ideas should be posted without evaluative comments or editing. Critical comments can too often prevent creative, but risky, suggestions from being presented. The teacher can often stimulate a stagnant session by proposing truly outlandish ideas.

Another way to encourage creativity is to use the SCAMPER technique (see Handout B-3). In this technique students reexamine and apply each of the SCAMPER elements to the ideas already suggested. Before using brainstorming in an activity it is well worth spending class time practicing these techniques.

The debriefing of a brainstorm should focus on the use of the ideas within the context of the teacher's purpose in conducting the brainstorm. For example, if the purpose of a brainstorm is to make students aware of how widespread the effects of air pollution are, the debriefing might focus on the sheer number of items generated and their seriousness. On the other hand, if the purpose was to generate ideas for research projects, some evaluation of ideas using specific criteria related to suitability for research might be in order during the debriefing.

Potential Uses of Brainstorming in STS

- Creating future scenarios
- Anticipating the risks and benefits of new technologies
- Identifying alternatives in decision-making occasions
- Identifying cross impacts between science-technology-society

Model Lessons Employing Brainstorming

Science Lessons

Technology Mind Walk
The Futures Wheel
Technology and Advertising
Energy Sources in the Good Old Days
Pesticides
Forest Products All Around Us

Social Studies Lessons

Knowledge, Skills, and Attitudes for the Year 2000
It's a Natural!
Bumper Sticker Position Statements

BRAINSTORMING

Rules of Brainstorming

1. Say anything that comes to mind.
2. Piggybacking on the ideas of others is good.
3. Don't evaluate or criticize what others say.
4. When you can't think of anything else, wait a minute and try again.

The SCAMPER Technique

S = substitute, subtract

C = combine

A = adapt, add

M = modify, minify, magnify

P = put to other uses, piggyback

E = eliminate

R = reverse, rearrange

CASE STUDIES

Background Notes

The case study approach involves providing students with situations in which there is a conflict or dilemma. Students then follow a step-by-step procedure to analyze the facts of the case, reach and support a decision, and weigh the consequences of that decision.

A case study requires students to ask questions, define elements important to a situation, analyze, synthesize, compare and contrast those elements, and make judgments. The students are, in short, practicing all levels of thinking, from simple recall to evaluation (see Handout B-4).

The case study approach may be applied to a variety of topics. In fact, this strategy can be implemented any time there is an issue or conflict situation to be considered. Teachers could use it to have students consider the conflict between promoting aviation while protecting the safety of passengers, for instance. Issues surrounding the role of government in energy development versus environmental conservation might be studied via this method, and so on.

The case study approach requires the teacher to serve in several capacities—diagnostician, discussion leader, and "climate-maker." The latter may be the most difficult for teachers. In order to develop a favorable classroom atmosphere in which to use the case study approach, the teacher must refrain from dominating class discussion by repeating, commenting on, or asking questions of the same respondent following each remark. Rather, questions and comments should be redirected to other members of the group or class. Also, biases of the instructor regarding a case should be contained; when they are expressed, they should be clearly open to class review and analysis.

Potential Uses of Case Studies in STS

- Court cases regarding science and technology issues
- Instances when policy-making bodies have acted on science and technology issues
- Futuristic scenarios in which students predict what may happen
- Story segments in which students decide what action should be taken
- Analysis of historical narratives, eyewitness accounts, and newspaper stories

Model Lessons Employing the Case Study Approach

Science Lessons

Environmental Impact Statements
Land Use
The Benefits of Technology
Genetic Screening
The Pine Beetle Controversy
Letters to the City Council
Ecology and the Government
Soil Deterioration

Social Studies Lessons

People and Machines
Doing Something About the Weather

USING THE CASE STUDY METHOD

The case study approach involves providing students with situations in which there is a conflict or dilemma. Students then follow a step-by-step procedure to analyze the facts of the case, reach and support a decision, and weigh the consequences of that decision.

A case study requires students to ask questions, define elements important to a situation, analyze, synthesize, compare and contrast those elements, and make judgments. The students are, in short, practicing all levels of thinking, from simple recall to evaluation.

Steps in Bloom's Taxonomy	Steps in the Case Study	Cognitive Skills Development
I. Knowledge	I. Determining the facts of the case	I. Remembering the facts Locating information Following directions Organizing information Researching Describing Sequencing Distinguishing fact from opinion
II. Comprehension	II. Summarizing facts Identifying issues	II. Summarizing Applying Abstracting Translating Transforming Figural decoding Describing
III. Application	III. Developing arguments	III. Analyzing facts and issues Translating Interpreting information Inquiring Classifying Equating Formulating concepts

Adapted from a handout developed by the Institute for Political/Legal Education, Sewell, NJ.

Steps in Bloom's Taxonomy	Steps in the Case Study	Cognitive Skills Development
IV. Analysis	IV. Breaking down facts/ arguments/issues	IV. Analyzing Theorizing Forming concepts Sequencing Translating Associating Thinking creatively/ divergently Imagining Elaborating Applying facts Simulating
V. Synthesis	V. Reaching a decision	V. Decision making Synthesizing information and arguments Formulating reasonable hypotheses Identifying central issues and underlying assumptions Defining Applying problem solving and decision making Drawing conclusions
VI. Evaluation	VI. Providing reasons for decisions Comparing decision to actual case outcome (if applicable)	VI. Critiquing Reasoning deductively Comparing/contrasting Drawing warranted conclusions Supporting arguments based on facts Participating

DEBATES/PANEL DISCUSSIONS

Background Notes

A debate can be an effective instructional method for helping students present and evaluate positions clearly and logically. A debate begins with the debaters' developing or being assigned a position on an issue. The intention of each debater is to persuade others that his or her position is the proper one. (In this way debate differs from discussion, which often calls for the cooperative thinking of members of a group in search of a solution or approach to a problem or issue.) A specific example of a way in which a debate might be a useful method is as a follow-up to a policy-making exercise. Participants who do not agree with the adopted policy might use the debate as an effective means of trying to change public opinion, which might in turn lead to a change in policy. Guidelines for conducting a debate are provided in Handout B-5.

A panel discussion is designed to provide an opportunity for a group to hear several people who are knowledgeable about a specific issue or topic present information and discuss their personal views. A panel discussion may help the audience further clarify and evaluate their positions in regard to the specific issues or topics being discussed and increase their understanding of the positions of others.

Steps in using a panel discussion include:

- Identifying, or helping participants identify, an issue or topic that involves an important conflict in values and/or interests. The issue or topic may be set forth as a topical question, a hypothetical incident, a student experience, or an actual case.
- Selecting panelists who are well informed about and have specific points of view about the issue or topic. A panel discussion that includes three to five panelists is usually most workable. Select a leader or moderator.
- Indicating to panelists what objectives the panel discussion is designed to promote and allowing time for panel members to prepare for the discussion. For some topics ten or fifteen minutes may be sufficient time for preparation, while in other situations panel members may need to prepare several weeks in advance of the schedule discussion. The teacher will be able to advise the panelist about time requirements.
- Deciding on the format that the panel discussion will follow. Various formats are appropriate. One proven format is described on Handout B-6.

Potential Uses for Debates/Panel Discussions in STS

- Evaluating positions in land use decisions
- Evaluating risks and benefits of new technologies
- Developing and presenting clear positions on controversial issues
- Providing background for decision-making exercises
- Exposing students to various views on controversial issues
- Providing a mechanism for presentation of student research results

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Background and handouts adapted from *Leader's Handbook* (Calabasas, CA: Center for Civic Education 1978). Used by permission of the publisher.

Model Lessons Employing Debates/Panel Discussions

Science Lessons

Scientific Experimentation with Animals
Soil Deterioration

Social Studies Lessons

Doing Something About the Weather
The Organ Hunter

GUIDELINES FOR CONDUCTING DEBATES

The following guidelines may be helpful in conducting a debate.

- Decide, or help students decide, on a subject for debate.
- Formulate the subject into a resolution; for example, "Resolved: that pesticides banned from use in the United States should also be banned from manufacture.
- Make certain that those participating in the debate are familiar with the procedures to be followed. (The form of debate described here is widely used but rather formalized. The purpose of the debate may make it desirable to use a less-formal procedure.)
- Select participants to take part in the debate. Divide the debaters into two teams, one team in support of the resolution (pro) and one team in opposition to the resolution (con). The most common number of members per team is two, but more than two may be used.
- Select a chairperson and a timekeeper.
- Allow sufficient time for participants in the debate to prepare "constructive arguments." A constructive argument should be based on from three to five major points that are logically developed and substantiated by factual evidence in support of a particular position.
- Conduct the debate according to the following procedures:
  1. The chairperson and the debaters are seated at the front of the class, usually with the team in favor of the resolution to the right of the chairperson and the team in opposition to the resolution to the left of the chairperson.
  2. The chairperson introduces the subject and states the resolution to be debated.
  3. The chairperson introduces the first speaker from the team in support of the resolution. Each speaker is introduced when he or she is given the floor.
  4. The first speaker from the team in support of the resolution is allowed a set amount of time to present the constructive argument he or she has prepared. The timekeeper, seated with the class, indicates when the time limit has been reached.
  5. The first speaker from the team in opposition to the resolution is introduced and asked to give his or her constructive argument. This procedure of presenting pro and con speakers alternately is continued until each debater has given his or her constructive arguments. After the first speaker, those who follow will probably need to adjust their prepared speeches to allow for what has been said by preceding speakers.
  6. "Rebuttal arguments" follow the series of constructive arguments given by both teams. The team in opposition to the resolution always begins the rebuttal argument series. Each debater is given an opportunity to speak extemporaneously for a set amount of time (usually less than the time allotted for original arguments), attempting to weaken the position presented by the opposing team. Rebuttal arguments also provide an opportunity to answer attacks that have been made by the opposing team. While rebuttal arguments are presented extemporaneously, debaters should anticipate possible positions the opposition might take and be prepared with appropriate counter arguments. No new issues may be introduced during rebuttal arguments.
  7. Debrief and/or evaluate the debate and the performance of the debate teams by informally polling the class to determine how many agree with each team. Class members should be asked to explain whether their own positions were strengthened or changed as a result of hearing the debate and to explain why.

STEPS IN CONDUCTING A PANEL DISCUSSION

The following procedures have been used effectively in structuring panel discussions.

1. The leader or moderator introduces the topic, and the panelists present their views and opinions about the issue or topic, each panelist in turn for a set amount of time.

2. The panelists discuss the issue or topic with each other by asking questions or reacting to the views and opinions of other panel members. A specific amount of time should be established.

3. The leader or moderator closes the discussion and provides a summary of panel presentations and discussion.

4. The leader or moderator calls for a forum period, during which members of the class may participate by addressing questions to various panel members or by voicing their views and opinions. The forum period should be conducted by the panel leader or moderator.

FIELD EXPERIENCES

Background Notes

Field experiences can make what students are learning in class more concrete and real. Field experiences may include standard field trips (e.g., visiting a water treatment facility), observation at public meetings (e.g., attending a public hearing on land use), and opportunities for actual field study (e.g., gathering data at a landfill). All these experiences can vividly illustrate the points being made in class presentations.

To be successful, field experiences require careful preplanning, in-class preparation, and debriefing (see Handout B-7). Follow-up visits or interviews, exhibitions of pictures taken on the trip along with other information gathered, or independent investigations of a similar kind may be planned as means of extending the field experience.

Individual field trips are recommended only for senior high students. These field trips can take place during the school day in schools with an open-campus policy, or they can occur after school. The purpose of individual field trips is to gather materials from specific organizations and interview members of those organizations. Such field trips give committees of students firsthand experience at evaluating other people's views. The students could use a tape recorder, and the tape could be shared with the entire class.

When using individual field trips to special-interest organizations, a teacher must be prepared to handle two situations. The first and simplest problem is that students sometimes return as converts who proselytize for a specific organization's point of view. The second and most difficult situation occurs when students return from such a visit and scoff at an organization and its viewpoint. One way to handle the second problem is to arrange individual field trips as preparation for debates. Students should try to do more than just gather information about an organization's point of view if they are expected to marshal that information into effective arguments.

Potential Uses of Field Experiences in STS

- Visiting facilities in which science is taking place (universities, medical research facilities, etc.)
- Visiting facilities to observe technology in use (water treatment facility, power plant, etc.)
- Observing public decision-making bodies considering STS issues
- Gathering data (making observations of pollution, testing water samples, etc.)

Model Lessons Employing Field Experiences

Science Lesson

Soil Deterioration

PLANNING FIELD EXPERIENCES

Preplanning

Field experiences take careful preplanning. Once you have decided on a site, make an appointment and visit it yourself. Visualize how the activity will take place. Anticipate problems and think about possible solutions. Discuss your plans with the school principal and obtain all necessary permissions from the site owner, school administration, and parents. Be sure that you have adequate help to supervise students. Other school staff, parents or other community volunteers, aides, or older students can provide assistance.

In-Class Preparation

Before you embark on the field study, prepare the students. Be sure that they understand the objectives of the field experience and how it fits into the current unit of study. Provide guidance if you want students to gather data through field notes, photographs, or other means. If necessary, establish ground rules for conduct during field experiences. Having students work in groups during field experiences often proves successful. Immediately before leaving the classroom, make sure students have all the materials needed

The Field Experience

During the field experience, circulate among groups. Show enthusiasm and participate in activities. Help students focus on the environment by using all their senses. Ask questions to help students observe and make comparisons.

Debriefing

Be sure to allow time after the field experience for class discussion and follow-up. Examine with students that they observed and learned, how it relates to the in-class activities they had been doing prior to the field experience, and what questions remain to be answered.

PROBLEM SOLVING/DECISION MAKING

Background Notes

Problem-solving and decision-making activities present students with opportunities to apply structural analytical tools to critical issues. Several models for teaching decision making are presented in the model lesson volumes. One such model is presented on Handout B-8. Each model shares five basic elements

1. Recognizing an occasion for discussion. Some action needs to be taken, but a clear solution is not obvious. In many cases, the primary problem may not be clear.

2. Stating the problem to be solved and the anticipated goals. Clarifying the problem and the basic values affecting the decision often helps to narrow the range of options available.

3. Identifying alternatives. Brainstorming multiple options can help move beyond obvious but shopworn decisions to more subtle and elegant solutions.

4. Predicting and evaluating the positive and negative consequences of the alternatives. Here students again apply various value measurements to weigh the quality of their proposals.

5. Making the decision. Despite the processes used to help reach a decision, taking the final step can require extra effort. Students must be encouraged to defend the reasons for their final actions.

The various models used in these volumes can easily be adapted for use in other activities. When the decision model itself is an important learning goal, it is critical that sufficient classtime be spend practicing the steps. Easy-to-solve sample problems used at the beginning of a unit can help familiarize students with the process so that later, more complex problems can be analyzed more quickly, accurately, and efficiently.

Potential Uses for Problem Solving/Decision Making

- Projecting the effects of new technology
- Examining the process of governmental decision-making on STS issues
- Deciding which development paths to follow with new technologies
- Evaluating past decisions

Model Lessons Employing Problem-Solving Activities

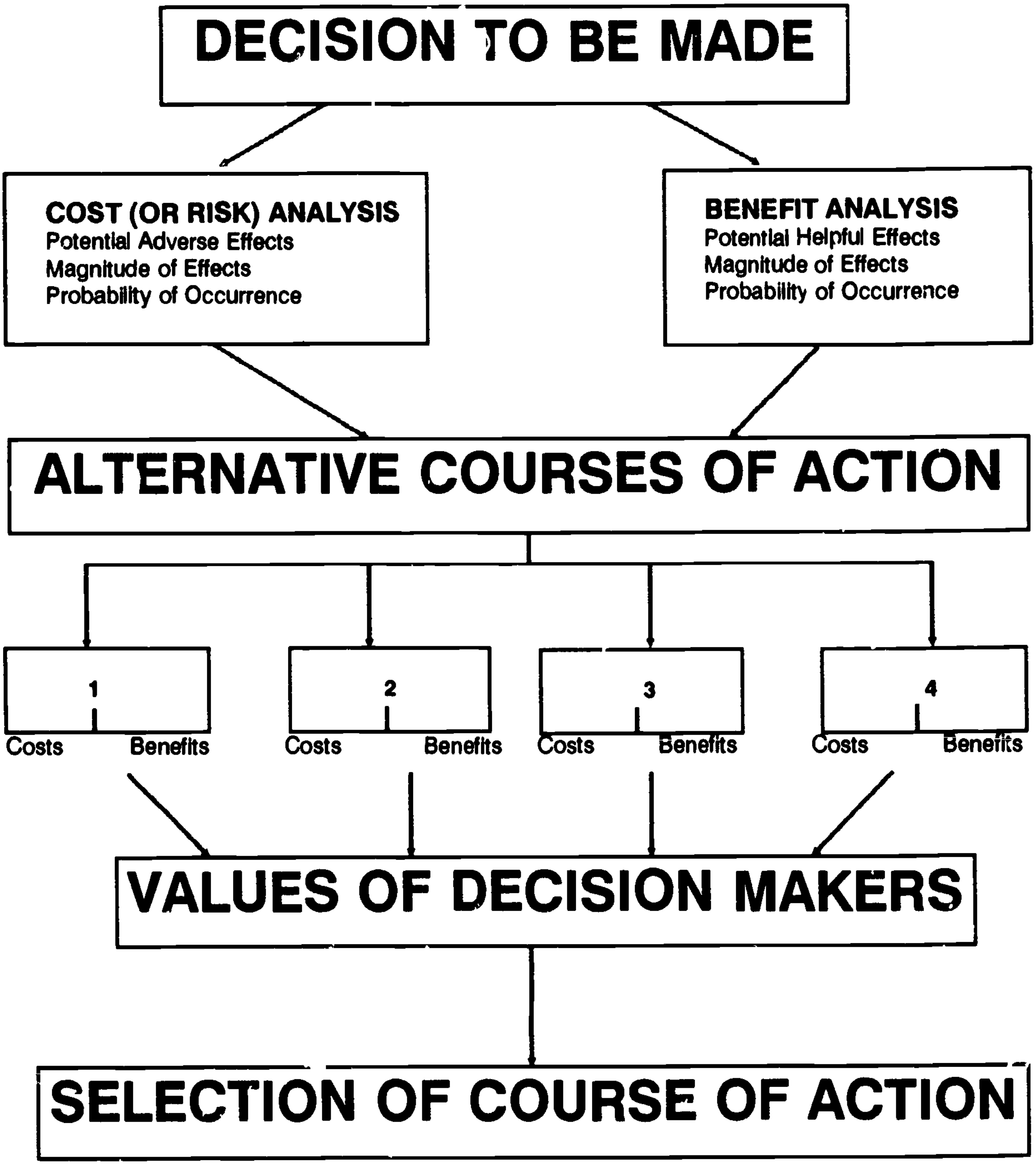
Science Lessons

What Would You Do If...?
Energy Sources
The Artificial Heart
Genetic Screening
Ecology and the Government
Scientific Experimentation with Animals

Social Studies Lessons

Solving the Problems of the World
The Effects of Individual Actions on Technology and Society
Renewable Energy and the American Age of Wood

A DECISION-MAKING MODEL



RESOURCE PEOPLE IN THE CLASSROOM

Background Notes

Because STS involves many specialized content areas, as well as public decision-making, use of community resources in the classroom is particularly appropriate. Depending on the issue being studied, scientists, doctors, engineers, public officials, business people, members of civic groups, and others may be appropriate resources to call upon. When considering how resource people could be used, do not limit yourself to guest lectures or interviews; resource people can also participate in such activities as simulated press conferences, panel discussions, role plays, and mock trials.

Locating resource persons requires time, but a few shortcuts are available. Consult other teachers who have used resource persons. Ask students what types of resource persons would be valuable and whether they know anyone who would fit the bill. Ask the officers of your PTA to organize a list of parent/speakers. Contact such umbrella organizations as the Chamber of Commerce; they may provide referrals as a public service. Consult the education editor of the local newspaper to talk with staff of a regional service agency.

When a classroom visit is arranged, the teacher should explain the goals and objectives of the presentation, making clear how the presentation fits into the overall unit of study. The resource person should be given information about the class (age, grade level, size, knowledge of the topic, presence of any students having disabilities that might affect the manner in which a presentation is made), the room size, setup, availability of special equipment), and the time available. Teachers may find it helpful to provide resource persons with the list of do's and don'ts provided on Handout B-9.

Teachers should also prepare students for the resource person's visit. Students should understand the purpose of the visit and complete any preparatory work in advance. Special procedures should be explained before the visit.

Each presentation by a resource persons should be assessed by the teacher, students, and resource person. The evaluation results should become a part of the teacher's permanent file on resource persons. Careful records of every presentation will allow teachers to make improvements, identify appropriate resources for future use, and avoid over- or under-use of particular persons. Combining the records of several teachers can result in a directory of resources.

Potential Uses of Resource Persons in STS

- Providing current data from their fields
- Judging class projects
- Mentoring individual or class projects
- Providing firsthand local perspectives on issues
- Participating in debates, panels, or simulations

Model Lessons Employing Resource Persons

Science Lessons

Food Additives

Social Studies Lessons

The Environment and Participatory Democracy
The Structure of Scientific Revolutions

DO'S AND DON'TS FOR THE RESOURCE PERSON

Don't:

- Lecture at students
- Use jargon or unfamiliar words
- Act condescending or omniscient
- Become angry at heckling or unresponsiveness
- React defensively to criticism
- Read a prepared speech
- Talk in a monotone
- Assume that students either have or lack knowledge about a given point

Do:

- Consider the age and experience of the audience
- Prepare adequately
- Maintain eye contact
- Solicit feedback frequently
- Encourage active participation early and throughout the presentation
- Be yourself: let your personality show; be real; smile
- Call on a variety of students
- Circulate around the room
- Involve the teacher
- Make sure that everyone hears all questions and answers
- Know the objectives of your visit and how it relates to the unit of study

ROLE PLAYS AND SIMULATIONS

Background Notes

Role playing can be an effective technique for focusing on the process of decision making and alternatives for conflict resolution. Role playing enables students to understand that others have points of view that are different from their own. It also enables students to learn appropriate behavior in a variety of settings.

Successful role playing depends on the establishment of a genuinely receptive atmosphere, based upon the teacher's belief that all individuals have the capacity to solve their own problems. To maintain this atmosphere, students should be permitted to make mistakes and to learn from them.

The peer group can also affect the success of role playing. Too often, children are stereotyped by their classmates in a way that tends to be self-fulfilling or stifling in a role-playing situation. Yet a child can learn to alter his or her behavior once new approaches have been introduced and practiced. A student's stereotypic classroom image should not be matched with a role of similar characteristics.

Teachers should not be discouraged if role playing appears to fail the first few times they use it. Everyone tends to be uncomfortable with a new strategy, and role playing is one of the more demanding ones. Students will likely demonstrate this discomfort either by acting silly or by being unwilling to participate. They need a lot of support and encouragement in the beginning.

Discussion of the role play should either be integrated with the activity or follow it immediately. Any significant lapse of time between role playing and the debriefing will dilute the value of the activity. The following questions may be useful in focusing the follow-up discussion:

- Were the plays realistic?
- Was the problem solved? Why or why not, and how?
- What were the alternative resolutions?
- Is this situation similar to anything you have personally experienced?
- How did you feel playing that role?
- If you repeated the role play, would you do anything differently?

Role plays are often a component of simulations, which allow students to experience vicariously a process that might otherwise be inaccessible to them. Simulations also allow students to experience processes and situations without risk. Students can practice decision making and even make mistakes in judgment without suffering serious consequences. Simulations are excellent reinforcers of skills or concepts with which students are already familiar. In addition, they provide a good change of pace.

Note that simulations usually involve both role playing and small-group work. If students do not have experience with these techniques, teachers would be wise to do some role plays and small-group exercises before attempting a simulation.

A few precautionary notes are in order. Some simulations require extensive teacher preparation. Teachers must ask themselves: "Is it worth it?" Competition is involved in some simulations. Teachers should be sure that students understand the purpose of the simulation and that "losing" the simulation does not mean students were less successful or learned less. Finally, students may view simulations as unrealistic, and some of them are. Teacher should try to relate the concepts and principles of the simulation to real-life experiences.

Background and handouts adapted from Arlene Gallagher, *The Methods Book* (Chicago: Law in American Society Foundation, 1979). Used by permission of the author.

A special form of simulation is the computer simulation. The computer can make simulations more realistic and effective by providing increased sophistication, access to databases, inclusion of random events, branching, and reinforcement. However, all computer simulations are not created equal; before choosing one, teachers should work through it to be sure it meets their class needs.

Handout B-10 provides some guidelines for conducting both role plays and simulations.

Potential Uses of Role Plays and Simulations in STS

- Recreating critical decisions in history (e.g., dropping the first atomic bomb)
- Role playing the decision-making process
- Acting out critical scenes from the lives of important inventors
- Working in groups to perform a convincing presentation to a decision-making body

Model Lessons Employing Role Plays and Simulations

Science Lessons

Groundwater Rights
Land Use

Social Studies Lessons

Fisk Kill in Riverwood—Who Pays?
A Social History Approach: Machine and Social Change in Industrial America
World Population Growth
Simulating the Strategic Defense Initiative
The Freeway Planning Game
A Resource Use Warm-Up
The Ocean Resources Game

GUIDELINES FOR CONDUCTING ROLE PLAYS AND SIMULATIONS

Below are some guidelines to follow in using a role play:

- Present the problem or situation. Be sure to give students adequate information to play their roles convincingly. Specify how much elaboration of the roles is expected/acceptable.
- Assign roles or solicit volunteers. An entire class may participate even if there are only two roles. Arrange the students in pairs or use trios, with the third student acting as observer.
- Get the class involved as quickly as possible. Don't spend too much time on the introduction.
- Role reversal can be a useful device when students appear unsympathetic to the opposing viewpoint or when a student has been stereotyped by peers.
- Initial role-playing activities should be simple, but they should become increasingly more complex if role playing is to be more than a simple exercise in dramatics.
- Don't expect polished performances.
- Vary role-playing activities. Students will tire of the same routine.

Simulations seem to run more smoothly if the following stages are used.

- Preparation. Break the game down by outlining the steps and allocating time periods for each step. Organize the classroom to suit the simulation, including rearranging furniture if necessary. Preteach the game to a small group if the directions are complicated.
- Playing. Introduce the game briefly by outlining the rules and procedures. Stick to the directions the first time you use a simulation. Start playing. Even if the simulation seems complicated, keep going. Let students figure things out.
- Debriefing. This usually consists of a follow-up discussion or other technique that helps students absorb and analyze what has happened. It is the most important stage of the simulation. First, the room should be rearranged in its usual setting. Second, a short one-page worksheet with questions designed to elicit reactions about the simulation will help to focus the discussion. It also helps to calm everyone down after what can sometimes be a chaotic and noisy experience. Then conduct small- and large-group discussions, using questions that isolate the purposes of the simulation. Be sure to relate the simulation to other experiences throughout the discussion.

SMALL-GROUP COOPERATIVE LEARNING

Opportunities for small-group cooperative learning, which a considerable body of research indicates is successful on both a cognitive and attitudinal level, can be built into many of the teaching strategies described above. Some suggestions for facilitating small-group work are given in Handout B-11, along with two forms students can use to evaluate their group's work.

Small-group work appears to be most successful when the following conditions prevail:

- One or two clear instructions guide work. Students have difficulty working in small groups if the task is unclear or so complicated they cannot remember the complete instructions.
- Adequate time is given to complete the assigned task in the small group.
- The task calls for cooperative work—not independent student work around a small-group table or group work that can be easily dominated by one or two students. For example, consider a small group preparing for a panel discussion on possible solutions to the problem of air pollution caused by automobiles. Each group member might choose one possible solution and research the costs and benefits of implementing that solution. Members would then report to the group on their findings, and the group would determine as a unit how to use the results in their panel discussion.
- The students have the knowledge and skills necessary to do the work.
- Groups have from two to five members. Varying the size of groups within this range will help prevent students from becoming bored by an overly rigid small-group structure.

Several of these factors point to the importance of choosing appropriate tasks for small-group work—the tasks selected must be amenable to some kind of cooperative work, be easily explained in a minimum number of steps, and be within students' capabilities. It is also important to keep in mind that success with small-group work requires practice. A teacher's first attempt at cooperative learning may not be the highlight of the year, but the potential pay-offs are worth experiencing some initial failures.

Potential Uses of Small-Group Cooperative Learning in STS

- Preparing role plays and simulations
- Collecting and displaying data from field experiences
- Researching several aspects of a complex topic
- Preparing for a debate or panel discussion
- Participating in problem-solving/decision-making exercises

Model Lessons Employing Small-Group Cooperative Learning

Science Lessons

Determining Priorities
What Would You Do If...?
The Biological Effects of a Nuclear Explosion
The Benefits of Technology
The Pine Beetle Controversy

Social Studies Lessons

Solving the Problems of the World
Furrows to the Future
Giving Up the Gun
Preparing Environmental Impact Statements
Warning Future Generations
Technology and Transportation
Science, Technology, and the Constitution

SUGGESTIONS FOR USING SMALL-GROUP COOPERATIVE LEARNING

Initial instruction for working in groups should remain simple. Begin with the basic criteria that will make the classroom manageable; these may depend on the maturity of the group. These basic rules should be posted in the front of the room and explained in some detail. These rules might include:

1. Move quickly and quietly into your groups
2. Use quiet voices (appoint one person for volume control)
3. Do not talk between groups
4. Appoint a leader to get the group moving

As students progress in their ability to work in groups, post other criteria or rules for working:

1. Appoint various roles (if necessary) such as leader, timekeeper to make sure the assignment can be completed, recorder to take the necessary notes.

2. Sentences that may help groups manage conflict include:

   I disagree because ...
   My opinion is ...
   Another way to look at this is ...
   Have you thought of ...
   What else can we look at?
   What do you think?

Two sample forms that may help students work on their group skills are provided. Form 1 provides for group as well as individual accountability. Form 2 might be given to a group in the middle of a unit to help them solve any problems they are having. You can use various tactics to promote cooperation. For example, you can collect one paper at random at the end of the period to evaluate. Each student within each group can be given a specific task to complete. Only so many resources can be made available so that sharing will be necessary.

As an incentive for better students to help less able students, you can devise a bonus system. Emphasize helping others to understand, not just giving them answers. Copying should be discouraged.

If you have an inordinate number of special needs children, assign learning buddies. The role of the learning buddy is to make sure the [illegible] can find the right materials and get the assignment done. Tests and quizzes might also be done in groups or with partners.

Give students specific feedback. Tell them what you saw that was especially effective and make suggestions about where they might improve. Focus some wrap-up sessions on group s[illegible]s. Assign writing activities that require verbalizing what students might do to improve their group skills.

Developed by Eugenia Moore, Fargo (ND) Public Schools.

Form #1

PROCESS EVALUATION

PERIOD: ______________________ DATE ______________________

ASSIGNMENT: ____

GROUP: ____

____

____

TOTAL POSSIBLE
5 POINTS

ON TASK: Working at ALL times on the assignment. If finished, complete the next assignment or read current events. 1 POINT ____________

COOPERATING: Everyone in the group must be participating. It is up to the group to see that everyone is contributing. 1 POINT ____________

BEHAVIOR: Quiet, businesslike, with NO disruptions or loud behaviors. 1 POINT ____________

FOLLOW DIRECTIONS: The assignment must be completed according to instructions. 1 POINT ____________

COMPLETED: The assignment must be completed. 1 POINT

TOTAL

Teacher Comments:

Form #2

COOPERATION EVALUATION

NAMES OF GROUP MEMBERS: ______________________

____

____

____

Directions: Rate your group on their cooperative learning skills by drawing a circle around the appropriate number.

4 = Excellent   3 = Good   2 = Fair   1 = Needs Work

1.	Someone in our group acts as a leader.	1	2	3	4	5
2.	Everyone in the group participates.	1	2	3	4	5
3.	Everyone in the group cooperates, i.e., helps solve group problems in a peaceful manner.	1	2	3	4	5
4.	Everyone in the group follows the directions.	1	2	3	4	5
5.	Our group does well at volume control.	1	2	3	4	5
6.	Everyone in the group aids in looking up information when necessary.	1	2	3	4	5

7. Overall rating of the group: (add all of the circled numbers together) ______________________

8. Problems of our group are:

We can solve our problems by:

SURVEYS

Background Notes

The purpose of conducting a survey of students' values or attitudes is to stimulate thinking on a variety of issues, many of them controversial. Such a survey can serve as a motivational device for later study by creating interest in the area of STS.

Another means of using the survey technique is to have students develop and administer a questionnaire. The survey can be taken within the school or in the larger community. Such an activity will not only expand students' thinking on a particular topic, but also develop their information-acquisition skills.

Some guidelines for administering surveys are given in Handout B-12.

Potential Uses for Surveys in STS

- Compare class attitudes before and after studying a topic
- Compare class positions with other groups
- Discuss the role of public opinion in making STS-related decisions
- Measure public awareness of local/national STS issues

Model Lessons Employing Surveys

Science Lessons

Global/Local Issues
Science and Technology in the News
Collecting Points of (pH)iew
Biodegradable and Nonbiodegradable
Nuclear Energy

Social Studies Lessons

Science and Technology in the News
Scavenger Hunt
Knowledge, Skills, and Attitudes for the Year 2000
Reaction Statements Warm-Up

USING SURVEYS WITH STUDENTS

The following format is suggested for administering a survey to students:

1. Have each student complete the survey independently in class, to ensure that the students do not discuss each other's responses before completing their own work.

2. Have students pair off and discuss their responses on a one-on-one basis. This will allow each person a chance to express his or her opinion without letting a few of the more-verbal students dominate the class.

3. Use a tally sheet to tabulate the responses for the entire class. To expedite this procedure, two or three smaller groups may be formed, with a student from each one designated to record the responses. The final tally should then be compiled and presented to the class. Students are often surprised to discover the range of opinion among their peers, since they may assume that everyone feels the same way on most issues.

4. Conduct a discussion based on the results of the survey. If the opinions of the class are virtually unanimous, it is not necessary to discuss a question at length. However, free and open dialogue should be encouraged when there is divergent opinion in the responses to a particular statement. The adult leader's role should be simply to facilitate input by encouraging students to express their opinions and support them. No attempt should be made to challenge student opinions or to reach a consensus at this time.

The following guides may be helpful in designing activities in which students survey others.

1. The topics on which students are seeking information should not be too broad ranging. A brief survey is preferable to a lengthy one.

2. Students will find it easier to gather and interpret data using questions with a limited number of possible responses.

3. A minimum number of people to be surveyed should be assigned each student.

4. Students should be briefed on survey etiquette. Potential respondents should be approached politely and asked if they would have time to respond to a brief survey; the purpose should be explained in a few words. If someone says "no," students should not try to change their minds. Those who consent should be thanked.

5. Students should analyze the data and be encouraged to present their findings in a variety of ways. Also encourage them to consider the limitations of their data.

Adapted from *Juvenile Justice: A High School Curriculum* (Sewell, NJ: Institute for Political/Legal Education, 1974), pp. 11-15.

STS MATERIALS AVAILABLE FROM THE SSEC

Science/Technology/Society: A Framework for Curriculum Reform in Secondary School Science and Social Studies, by Faith M. Hickman, John J. Patrick, and Rodger W. Bybee (1987).

Today's young citizens must be prepared to deal with societal issues related to science and technology. This book provides a much-needed guide for designing units of study that integrate knowledge from science and social studies. Included are guidelines for selecting STS content, developing skills in analyzing STS issues, developing positive attitudes toward science and technology, assessing options for the design of STS curricula, and infusing STS into secondary science and social studies courses.

Order #313-6 55 pp. $6.95 Quantity ________

* * * * * * * * * * *

Science/Technology/Society: Model Lessons for Secondary Social Studies Classes, edited by Robert D. LaRue, Jr. (1988).

Science/Technology/Society: Model Lessons for Secondary Science Classes, edited by Janice V. Pearson (1988).

The editor of each volume has compiled more than 35 model STS lessons that can be used by secondary teachers in a wide variety of existing courses. Matrices show the links between the lessons and standard course outlines. Many different topics and instructional strategies are represented in the lessons.

Social studies volume:	Order #315-2	218 pp.	$15.95	Quantity ________
Science volume:	Order #316-1	216 pp.	$15.95	Quantity ________

* * * * * * * * * * *

Science/Technology/Society: Training Manual, edited by Laurel R. Singleton (1988).

This manual suggests ways in which a variety of workshops on STS can be organized and conducted. The manual provides activities to build awareness and assist in implementation. Also presented are masters for numerous transparencies and handouts for use in training activities.

Order #314-4 172 pp. $9.95 Quantity ________

* * * * * * * * * * *

Creative Role-Playing Exercises in Science and Technology, edited by Lynn S. Parisi (1986).

The five activities in this publication were developed to help prepare high school students for participation as informed and interested citizens in the making and analysis of public policy related to science and technology. Each activity focuses on a science-related issue and integrates the presentation of scientific and societal data with a risk assessment and decision-making exercise. Topics covered in the activities are disposal of spent nuclear fuel, recombinant DNA research, acid rain, toxic waste, and mining the seabed. Many reproducible student handouts are included.

Order #306-3 756 pp. $24.95 Quantity ________

* * * * * * * * * * *

Connecting Science, Technology, and Society in the Education of Citizens, by John J. Patrick and Richard C. Remy (1985).

Topics covered in this book include challenges associated with teaching about science-related social issues, the extent to which these challenges are being met, ways in which educators can improve education in science/technology/society issues, and promising practices that can build connections between social studies and science.

Order #2[illegible]8-9 90 pp. $8.50 Quantity ________

* * * * * * * * * * *

Teaching About the Future: Tools, Topics, and Issues, by John D. Haas and others (1987).

This resource contains three major sections. The first presents six mini-lessons designed as warm-ups to the topic. The second focuses on the methods of futurists, and the third contains activities on future issues: energy resources, food, the health technology revolution, transportation, work and leisure, and more!

Order #311-X 176 pp. $21.95 Quantity ________

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