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FOREWORD

Using Social Issues as Contexts for K-16 Science Education

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Abstract

Social issues provide real life and motivational questions which are successful in engaging the minds of many people (especially students). When dealing with social issues, students see the importance of so-called basic concepts and skills in dealing with them. For most persons real mind engagement rarely occurs in educational

settings. One important effort in science education to illustrate the advantages of the use of social issues as organizers for instruction has been termed the science-technology-society (STS) approach. A history of this approach in the U.S. is presented along with a fifty year history of its discovery and development highlighting the experiences of the author. This history includes major happenings in science and technology education, the challenges encountered, milestones identified, and an envisioned future.

Science-Technology-Society (STS) and Typical School Science

The 1970s have often been described as years of protest—years when government policies, social justice, family structure, the economy, and established organizations and structures were called into question. This decade resulted in many educators questioning the wisdom of the reforms of the 60s which followed the Soviet moves into space with the first man-made satellite Sputnik. Even though Sputnik was a significant technological achievement, it stimulated many changes in school science including a focus on basic science constructs. These changes were supported by the U.S. government (mainly the National Science Foundation) in expanding the national role in reforming school science with scores of new national "Curriculum" developments at a cost of over $2 billion over 15 years—1957-1972. These efforts were headed by scientists at some of the most prestigious universities across the U.S. Jerrold Zacharias, a physicist, headed the first of these developments at the Massachusetts Institute of Technology. It was conceived in 1956—prior to the launching of Sputnik. Zacharias' project was called the Physical Science Study Committee (PSSC) which sought, among other things, to rid the school physics course of "technology" and to present the essence of physics "as it is known to scientists". It was not an STS course—but it represents the extremes of the 60s when nearly all the curriculum efforts sought to identify major constructs that characterized the various disciplines of science (at the secondary level) and included information about and practice with the skills (processes) used by scientists in their quest for more and better understanding of the objects and events comprising the natural universe.

The 1970s ushered in protests of schools as social institutions and of their curricula which seemed not to serve students well. Such times of doubt and emotion often result in new ideas for resolving the perceived crises. There have been several attempts to reform science education and in ways that served the current and future needs of students better over our 200 years as a nation. However, few of these received national attention and funding. STS was one of the ideas that emerged at the end of the 70s. One of the largest of these to emerge early in the 80s was funded by the U.S. National Science Foundation (NSF) headed by Rustum Roy, an internationally respected materials scientist (College of Engineering) at Penn State University. It was called Science through Science-Technology-Society (Roy, 1984).

STS had emerged in the U.K. as a national priority in the last three decades of the 20th Century. It was a reform effort that grew rapidly in Europe with major projects centered in the U.K., Netherlands, Scandinavia, and Israel. All of the projects sought to use science and technology to resolve social issues. It was a philosopher in the U.K., John Ziman, who suggested the term STS to cover the several reforms that moved beyond a re-shuffling of science concepts and a concern for process skills—both without concern for real world contexts or any consideration other than the major concepts of the basic science disciplines. Rarely was there any philosophical, historical, or sociological basis for the information and skills identified as important and worthy of "impartation" to students. Ziman (Ziman, 1980) reviewed the situation carefully and defined the various aspects of STS and their various proponents.

Project Synthesis, an NSF research project, conceived by Norris Harms at the University of Colorado, was developed in the mid 70s and included four person teams of national leaders in elementary science, biology, physical science, inquiry, and STS (Harms, 1977). The research used three major NSF studies that included ten case studies (Stake & Easley, 1978), a national survey of what was occurring in the U.S. schools in terms of science education (Weiss, 1978), a review of relevant research literature (Helgeson, et al., 1977), as well as the Third National Assessment of Educational Progress (NAEP) which was released in 1978 thereby providing information about student learning. The 1978 NAEP results also included the first look at the affective domain in addition to student assessment of basic science concepts. These four data sources provided the research teams with opportunity to synthesize the "Actual State" of science education as the 80s emerged in each of the five areas listed above. Other research, government reports, textbook analyses, and indicators of past failures comprised other data that the research teams used to craft a "Desired State"—or, visions of what indicators suggested as means for achieving reforms and greater success in terms of real student learning with understanding and utility. Project Synthesis provided an opportunity to chart the pathway to the future; it provided a contrast to all the negative reports and analyses which characterized educational life in general during the early 1970s.

One important aspect of the Project Synthesis research efforts was the Goal Clusters that Harms used to frame the three year study. These four goals included: science for meeting personal needs, science for making societal decisions, science for career awareness, and science for further academic preparation. These goal areas were all considered important to the research teams. Unfortunately, however, only the last goal was found to be in evidence in classrooms of more than 90% of the science teachers and almost 100% of the 16,000 school districts in the U.S. Almost everyone assumed that academic preparation was most important and dictated what was done with respect to science education in K-12 settings.

STS was emerging as a major reform effort in the U.S. as the 80s arrived. It was a reform that was seen as focusing on a science for all and as meeting the goal areas other than academic preparation. For many of us this was the most important development and began a debate of the importance and centrality of social issues as organizers and a form of content for school science.

STS and Typical School Science

Critics of STS fear that major science concepts will be missed if social issues are used as organizers for school science courses. The typical view of science curricula and science textbooks is one of dividing the major constructs by discipline (biology, chemistry, earth science, and physics) and then defining the major concepts of each discipline for presentation to students. There is fear that such important ideas will not be encountered and given to students if they are not identified in curriculum frameworks and textbooks for students to master directly—usually in terms of repeating what they are told or that they read in textbooks—or fill-in-the blanks on worksheets. Teachers like to assure students that they do need to know "the basics", that they will find uses for them later, that they will appreciate (in college or later in life) what they study and what the teacher expects them to know.

We continue to think and act by using Aristotle's identification of the two foci he found in studying the ancient schools of Athens in 300 B.C. He reported there were equal defenders for: 1) schooling to help students learn what will be useful in living versus 2) schooling that will produce students who can perform and to act in ways society has defined as important. In many respects these two views of education exist today and constitute current debates. It is interesting to many others to point to the efforts for reform of school science during our 200+ years of history. With at least 40 major national reforms, all but our efforts in the 60s following Sputnik were toward achieving a more useful (practical) science education. In the 1960s we were focused on transmitting the "Science known to scientists" with little attention to science for any reason other than someone has argued that major concepts are important (basic). One could ask: "Important to whom? Basic to what? Where could they/should they be used?"

Project Synthesis, using information from ten case studies (Stake & Easley, 1978), national survey data (Weiss, 1978), and a review of the research literature (Helgeson, et al., 1977), provided us with a wealth of information about the status of science education in the U.S. schools. In a very real sense this status could be summarized with one word: TEXTBOOKS. This fact continues (though less intense) as reported in Weiss' third comprehensive survey of what that is occurring in U.S. schools with respect to science (Weiss, 2001).

Although we like to pride ourselves with decisions being placed with each of the 16,000 independent school districts in the U.S. regarding what should be taught and how it is taught, nearly all that is found in all the districts is depressingly the same. Textbooks continue to be good predictors of what most students experience science to be. For the past several decades the science students experience in schools could be determined accurately in terms of what science was included in the three most used textbooks at a given grade level. Looking at but three textbooks is an accurate indicator of what 90% of all students at the grade will have as concept organizers, as activities to experience, as information to consider, and as indicators of what will be used to assess their learning (Harms & Yager, 1981). Further, textbook analyses reveal that the most used ones contain the same information, topics, and verification-type activities (so-called laboratories or investigations). Again, there is 90% agreement among the texts as to what content is included and the suggestions provided for how teachers should approach the content.

This focus on textbooks as indicators of what school science is like for almost all students in almost all schools remains even after the American Association for the Advancement of Science has condemned nearly all mainline science textbooks as inadequate and inappropriate (AAAS, 1999; Roseman, Kesidou, & Stern, 1997). None measure up to the guidelines-defined by the AAAS Project 2061 in their "Science for All Americans" (AAAS, 1989) and their "Benchmarks for Science Literacy" (AAAS, 1993).

The major problem, of course, is the fact that commercial publishers will publish any material that 20-30% of the teachers and students will buy. The textbooks available are what teachers, students, and parents want. They match state curriculum frameworks. They meet all the requirements outlined in the 17 states with required criteria for use of state funds for textbooks. Many of these are the largest states, thereby meaning that their specifications must be met in order to sell the books in those states—at least with tax funds. The schools (and teachers) are free to buy (or to not buy); but in reality they must take what is approved unless they have another way to procure and pay for materials.

Could AAAS be more effective in condemning criteria used for textbook adoptions in the states with statewide guidelines? Is there any research evidence to suggest that the degree-of-fit of published materials with the AAAS Benchmarks is the correct content and order for content for textbooks? Are textbooks even necessary and required for effective science instruction? Or, are they more like religious documents where followers are helped to decide what is important, what students must remember and believe to be successful? What seems to be missing in most textbooks is a focus on the whole of science, upon student mind engagement, upon a reunion of science and technology, upon the identification of assessment as a fundamental part of science, and upon basing student assessments on something other than what concepts students remember and how to perform the skills directly taught to students?

Inquiry is basic to science. Although attention to it in most reform efforts in U.S. schools for nearly 100 years, it has been an illusive goal (or content form) to achieve. It was the one common goal for the programs of the 60s. One elementary school program, Science—A Process Approach, focused only on the identification of fourteen process skills and helping teachers teach them—but out of any real-world context. Classification, for example, was taught as a sorting exercise—again for no reason other than grouping is important (at least as proclaimed by the developers and teacher users). Too few see inquiry as a descriptor for science. Scientists are inquirers. They are curious, asking questions, and collecting evidences that their answers/explanations of events and objects in the natural universe are valid.

Few view inquiry as a form of content, or as specified processes used by scientists, or as an example of the whole series of actions that define science, or as a teaching tool as well as a form of content. Joe Schwab, a leader during the 60s who led in promoting science as inquiry, suggested spelling it with an "e" to catch people's attention (Schwab, 1962). It did not seem to work! As important as inquiry is to science education, its many faces, its usage, its meaning in the lives of students (and teachers), make it elusive and sometimes difficult to describe fully and in ways that go beyond an elaboration of growing lists of important (basic) concepts offered for students to learn.

Although inquiry was one of the focus areas for Project Synthesis, it was reported after four years of study that no science exemplary programs illustrating inquiry in schools in grades K-12 could be found. Perhaps closest were examples in the STS efforts. This was another reason that many of us embraced STS and its focus on social issues as a way to illustrate real inquiry—not from studying it, or doing teacher directed "inquiry" activities, or reviewing "the" scientific method, or from teacher questioning. Inquiry must be seen as the whole basis of two unique human enterprises characterizing science <u>and</u> technology. One of the greatest failures in K-16 science is the absence of inquiry and the failure to understand what it is and ways of enabling all to experience it—even once over the K-12 continuum of experiences with science studies.

The National Science Education Standards (NSES)

The National Science Education Standards (NSES) in the U.S. were published in 1996 after four years of debate and argument (National Research Council [NRC], 1996). The NSES cost a total of $7 million dollars—over $26,700 per page. No other set of standards required more than $250,000 of federal funding for the total effort. The Standards were meant to provide a vision for science education for a decade after their publication—or 2006. As that date approaches, there is every indication that the visions will not be realized—perhaps because STS reforms seem stalled. The focus on social issue was envisioned by the thousands involved with producing the NSES. Examples included illustrate STS—but the focus is missed when users seem to revert to developing a new order for considering the concepts and skills identified as important. Perhaps far too little attention has been directed to the Professional Development Standards and those directed at changing school programs and the system of schooling in the U.S.

There was debate concerning who would develop the NSES. The American Association for the Advancement of Science (AAAS) volunteered to head the efforts with their Project 2061 efforts underway—surely "Science for All Americans" provides a wonderful philosophical basis for reforms (AAAS, 1989). The National Science Teachers Association (NSTA) was also involved in developing its Scope, Sequence, and Coordination Project (SS&C) prior to 1992 (NSTA, 1992). SS&C actually enjoyed more NSF funding over a seven year period than Project 2061 and operated initially in six states and later in nearly 30 independent districts. On the other hand, Project 2061 operated in only six school districts in the U.S. where the goals of Project 2061 were implemented. NSTA offered its expertise and work with SS&C as important as NSF sought to fund the development of National Standards—after realizing the value of the NCTM Standards in mathematics. In the case of NCTM no federal funding was provided to prepare the Standards. With the debate between AAAS and NSTA the compromise was to have the science standards developed by the National Research Council of the National Academy of Science with input from the leadership of both AAAS and NSTA. The climate for funding and developing national standards had changed and the value seen for the new directions as each discipline in the basic school curriculum moved to the preparation of their own standards—most with significant national funding.

The NSES goals were meant to frame the teaching, staff development, assessment, content, program, and system efforts as visions for change and reform were developed. These goals represent a step beyond those central to Harms' earlier Project Synthesis. The four goals (justifications) for K-12 science include preparing students who:

- experience the richness and excitement of knowing about and understanding the natural world:
- use appropriate scientific processes and principles in making personal decisions;
- engage intelligently in public discourse and debate about matters of scientific and technological concern; and
- increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers.

(NRC, 1996, p.13)

The similarities of the NSES goals for science education resemble those used with the 1978-81 Project Synthesis. The big difference is the elimination of the academic preparation goal that was included in the Project Synthesis research. The NSES indicate that academic preparation is an unimportant goal—one not appropriate for most K-12 students. In its place is goal number one as indicated above. For many this goal is the most important one for school science. If students were to experience the whole sequence that characterizes real science, all the other goals could be achieved more easily. Basically, the goals do not suggest any content or any glamorized process skills that must be transmitted or experienced for their own sake. Paul Brandwein has called for teachers and schools to insure that each high school graduate have one full experience with science (Brandwein, 1983). He suggested that this would create a revolution in science education— something we still badly need. Some STS enthusiasts suggest that one such experience each year would be a better goal during the K-12 years—a 13 year continuum of science in school—and perhaps one each 9-week grading period would be an even better goal!

Although many are willing to state that goal one is most important—perhaps worthy of 50% of our efforts, the other three goals all exemplify the philosophy and goals of the STS approach to science in schools.

The NSES close each chapter with a summary that indicates the typical situation where less emphasis should be given and more emphasis conditions that correspond to each less emphasis one. In a very real sense the “more emphasis” descriptors represent the NSES visions for change and the reforms for which so many yearn. Again, these more emphasis conditions represent well what STS efforts are about.

The teaching standards are recognized as basic and of utmost importance. These standards appear right after the goals and introductory definitions. This indicates their importance. Interestingly, there was little debate or any problems with the visions for changing teaching as the NSES were developed. Teachers, science educators, scientists, and the many revisions of the early drafts of the NSES were supportive of the contrasts the “teaching” team for NSES proposed. These changes in emphasis for teaching include:

Less Emphasis	**More Emphasis**
Treating all students alike and responding to the group as a whole	Understanding and responding to individual student's interests, strengths, experiences, and needs
Rigidly following curriculum	Selecting and adapting curriculum
Focusing on student acquisition of information	Focusing on student understanding and use of scientific knowledge, ideas, and inquiry processes
Presenting scientific knowledge through lecture, text, and demonstration	Guiding students in active and extended scientific inquiry
Asking for recitation of acquired knowledge	Providing opportunities for scientific discussion and debate among students
Testing students for factual information at the end of the unit or chapter	Continuously assessing student understanding
Maintaining responsibility and authority	Sharing responsibility for learning with students
Supporting competition	Supporting a classroom community with cooperation, shared responsibility, and respect
Working alone	Working with other teachers to enhance the science program

(NRC, 1996, p. 52)

The visions for effective Staff Development programs follow the teaching standards. It is of interest to point out that these standards were added in the final stages of preparation of the published version of the Standards. There were no special working committees for them. But, preparing teachers for the kind of teaching and assessment envisioned and for dealing with a new definition for science content made the need for Professional Development Standards obvious for all. The fourteen changes in emphasis envisioned for Professional Staff Development programs include:

Less Emphasis	**More Emphasis**
Transmission of teaching knowledge and skills by lectures	Inquiry into teaching and learning

Learning science by lecture and reading	Learning science through investigation and inquiry
Separation of science and teaching knowledge	Integration of science and teaching knowledge
Separation of theory and practice	Integration of theory and practice in school settings
Individual learning	Collegial and collaborative learning
Fragmented, one-shot sessions	Long-term coherent plans
Courses and workshops	A variety of professional development activities
Reliance on external expertise	Mix of internal and external expertise
Staff developers as educators	Staff developers as facilitators, consultants and planners
Teacher as technician	Teacher as intellectual, reflective practitioner
Teacher as consumer of knowledge about teaching	Teacher as producer of knowledge about teaching
Teacher as follower	Teacher as leader
Teacher as an individual based in a classroom	Teacher as a member of a collegial professional community
Teacher as target of change	Teacher as source and facilitator of change

(NRC, 1996, p. 72)

Assessment is a basic ingredient of science. The NSES elaborate a central role since assessment (evidence gathering) is such a critical facet of the science enterprise. Changes in Assessment are included before any consideration of content or a curriculum structure. The visions for desired assessment practices in the Standards include:

Less Emphasis	**More Emphasis**
Assessing what is easily measured	Assessing what is most highly valued
Assessing discrete knowledge	Assessing rich, well-structured knowledge
Assessing scientific knowledge	Assessing scientific understanding and reasoning
Assessing to learn what students do not know	Assessing to learn what students do understand
Assessing only achievement	Assessing achievement and opportunity to learn
End of term assessments by teachers	Students engaged in ongoing assessment of their work and that of others
Development of external assessments by measurement experts alone	Teachers involved in the development of external assessments

(NRC, 1996 p. 100)

A major direction with respect to content was the identification of eight facets of content. These eight change the focus from a traditional discipline focus and a listing of major concepts under each discipline heading to a much broader listing that is more indicative of the goals (justifications) for science in K-12 schools. These eight facets of content elaborated in NSES are: 1) Unifying Concepts and Processes; 2) Science as Inquiry; 3) Physical Science; 4) Life Science; 5) Earth and Space Science; 6) Science and Technology; 7) Science in Personal and Social Perspectives; and 8) History and Nature of Science.

Just as goal one is considered the most important one, content focus is similarly considered the most important. It was envisioned as being so basic that it was first thought to be included as the preamble for each content section of NSES. However, many felt that too many would simply move to a new listing of basic discipline-bound concepts and ignore the preamble. Although life, physical, and earth/space science still appear, some lists combine them into a listing of basic science concepts as a single content focus—thereby suggesting a more integrated approach to the major concepts comprising modern science. Major debates occurred in identifying these eight content constructs and the specific content included in each of the "discipline-bound" content areas. For many persons interested in the NSES, the first look is at these lists of concepts (and, sometimes many do not even look at the goals and/or the visions elaborated concerning changes in teaching, staff development, and/or assessment).

Important for STS and the reforms it advances are the four other content facets, namely: science for meeting personal and societal challenges (referring to goals 2 & 3), technology (which now enjoys a whole set of standards produced by International Technology Education Association [ITEA, 2000]), and the history and philosophy of science, and science as inquiry.

The more emphasis conditions for inquiry represent what STS is all about and indicate why the use of social issues is considered essential. The more emphasis conditions for inquiry are meant to reverse the failures in 1981 for finding examples of teaching science by inquiry in U.S. schools. After the Project Synthesis report, Paul DeHart Hurd (Hurd, 1978) reported:

> "The development of enquiry skills as a major goal of instruction in science appears to have had only a minimal effect on secondary school teaching. The rhetoric about enquiry and process teaching greatly exceeds both the research on the subject and the classroom practice. The validity of the enquiry goal itself could profit from more scholarly interchange and confrontation even if it is simply to recognize that science is not totally confined to logical processes and data-gathering"
>
> (Hurd, 1978, p. 62).

The NSES envision a focus on inquiry to change from similar contrasts between specific less to more emphasis conditions, including:

Less Emphasis	**More Emphasis**
Activities that demonstrate and verify science content	Activities that investigate and analyze science questions
Investigations confined to one class period	Investigations over extended periods of time

Process skills out of context	Process skills in context
Emphasis on individual process skills such as observation or inference	Using multiple process skills—manipulation, cognitive, procedural
Getting an answer	Using evidence and strategies for developing or revising an explanation
Science as exploration and experiment	Science as argument and explanation
Providing answers to questions about science content	Communicating science explanations
Individuals and groups of students analyzing and synthesizing data without defending a conclusion	Groups of students often analyzing and synthesizing data after defending conclusions
Doing few investigations in order to leave time to cover large amounts of content	Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content
Concluding inquiries with the result of the experiment	Applying the results of experiments to scientific arguments and explanations
Management of materials and equipment	Management of ideas and information
Private communication of student ideas and conclusions to teacher	Public communication of student ideas and work to classmates

(NRC, 1996, p. 113)

Centrality of Contexts for Reform

Since a starting point for this essay was the centrality of STS as my introduction to using social issues in science classrooms and in schools, it should be seen as a way of promoting learning across an entire school and beyond as well as with the immediate family and local, state, and national communities. In essence social issues provide the contexts which invariably require the concepts and skills that comprise science programs in typical schools. Instead of starting with a curriculum and proceeding through it, the student is more central and becomes the magnet for the need of what is generally taught merely because it is there and outside persons have dictated it and assumed its relevance for all learners. Generally, everything is taught "because it will be useful—Trust Me!" But, for most students such use is never found. Instead the study is something that is done for all who wish to pursue college/university study, especially for medicine, health sciences, and engineering—and also important for performing well on college entrance examinations. I would argue that our major problem remains: science is justified and offered as important for further (and deeper?) study of science at the next level (grade by grade in schools) or for the college track in high school and for college entrance. It is not seen as something important and useful for all.

STS by name broadens the focus to something other than a consideration of the concepts that characterizes biology, chemistry, physics, and to a much lesser extent, the earth/space sciences. It also includes technology (the human-made world) as well as a focus on the objects and events in the natural universe. And, it includes society which is easy for life science enthusiasts since it represents a level of focus in biology (i.e., ecology). It is also related to the social studies (ala sociology, economics, government, geography, and psychology).

But, it is insufficient to assume a universal understanding of science itself. To most persons science is what is studied in school. What is studied usually ends up as topics or chapters organized around precise concepts which are traditional features of textbooks, and often coincide to courses in college departments where science teachers have had direct experience as students during their preparation.

Science needs to be understood by all as a human endeavor which all people can understand, experience, and use. The NSES goals previously elaborated and discussed exemplify a holistic view of science. Carl Sagan (NRC, 1998) has emphasized a vital point when he observed that every human starts as a scientist. However, as the child grows and attends school, he/she is discouraged from practicing real science and is taught skills in science classes which are alien to science itself. Science consists of four essential features—all of which should be a part of school and every child's experience. These include:

1) asking questions about the objects and events observed in the natural world;

2) proposing answers (possible explanations) to these personally constructed

questions;

3) designing tests or preparing logical reasons to establish validity for the proposed answers;
4) communicating the question, proposed explanations, and the evidence assembled to support the explanation to others (especially others, who have pondered and investigated similar objects and events in nature).

Science is a human endeavor which is characterized by curiosity and wonderment, attempts to explain, and the desire to determine the accuracy of each explanation advanced, and responsibility for sharing and communicating the process to others (in science at the research level, this means to others comprising the science establishment). If science were advanced with this four point sequence, goal one of NSES would be met. And yet, it rarely occurs and remains a major issue in science education. But, how would real science ever be offered in a textbook, a teacher's lecture, or a state framework? But, complete science is what STS is about—and science for all!

Technology was to be eliminated from all school science programs in the 60s. Technology was relegated to the shop; it was placed in vocational departments designed for the non-college bound students. Interestingly, it was not seen as preparation for engineering or any other collegiate endeavor.

Technology can simply be defined as a focus on human-made world, including television, airplanes, highways, architecture, computers, atomic energy plants, and thousands of other "technological" achievements so central to our living. Is it any wonder that eliminating technology content from school science meant eliminating the context so many found interesting and relevant?

Although the procedures for technology are the same or for science, there are two major differences. In the case of technology, the answer is the starting point. For example, we want an airplane, new energy source, a better highway, an air conditioner, and thousands of other "technologies" that are so familiar to our daily lives. We can dream of things that will improve our lives and then use our knowledge of the natural world to produce them. In the case of technology the results are getting the world (situation, gadget, structure) we wanted and needed. In the case of science, we only have the satisfaction of knowing better—or more completely—how the objects and events in nature operate or come about; our curiosities are satisfied for their own sake—without getting a product we wanted when we started.

Society is a term in biology that defines a group of living forms with certain features. Common social structures can be (and are) studied, such as bees, ants, monkeys. But, of greater interest perhaps is human society—and the various interactions of it as cultures have developed and as human evolution has occurred over thousands of years.

Society—for many STS enthusiasts—is where the study of technology and science should begin. It begins with humans and their minds. It exemplifies the one distinguishing feature of humans and other forms of life. For technology the relationship and value of the procedures and of the products are easy to see. The human intellect is titillated in wanting something seen to improve human existence. The question becomes "how to get it?" For science it is but curiosity about stars, mountains, oceans, living forms, light, sound, energy, substances.

Understanding science as a kind of human endeavor seems illusive in typical courses and where teachers purport to help students "learn" science. Instead most never experience real science. Often they experience technology—even though it is often but replicating something already "discovered". And yet, this re-discovery of the laws of nature never encourages a real (and complete) experience with science. Seldom does typical school science start with an open entry into a study of the objects and events that comprise the natural universe.

STS should stand for society-technology-science (in this order). It is a way of illustrating how science operates, what it is, how previous "knowledge" and skills can be used to answer further questions of the objects and events found in nature. Science starts with people's questions. So should science teaching! Society should be the starting point for science and technology as experienced in courses.

Social issues is a term used here to mean the problems/controversies/debates in human society that people identify. These issues (questions) about the natural world and the human-made world provide motivation for most people. They can and should provide the structure for science (and technology) studies. Instead most structures are determined by teachers, curriculum guides, textbooks without any other reason than someone else has determined their importance—and made promises about their use later in life for dealing with the issues/problems of our time. But, again this is our failure—the realization between what is taught—and seemingly learned—and that that can be used. This USE could be basic to the realization of goals two, three, and four of the NSES. Once again these goals—though elaborated as justifications for school science for nearly 25 years—have provided little evidence (from textbooks, state frameworks, research reports) that the goals are being met in any class, or observed or measured in any way. Using social issues as "up-front" organizers for science and technology studies seems to be an answer—one deserving trial and "evidence gathering" concerning their effectiveness. But, how to change common practice? This is where the NSES visions for changing programs and systems are needed. And yet, these standards receive scant attention by political leaders and policy makers. All seem to start with identifying minute concepts and special (often glamorized) skills, and then encouraging drill and practices with them as precursors to solving problems later. The failure is one of providing no meaningful context or situations or indicators of the utility of the skills and concepts we are so quick to teach.

Joe Piel, the chair of the STS team for Project Synthesis, has been a proponent for the STS approach since his early involvement with a curriculum project called "Engineering Concepts Curriculum Project"—later called the "Man-Made World" in the late 60s. This program for use in high schools made little impact for the reasons outlined above. It was not considered important for college entrance, but merely as a way of helping students experience real (traditional) science or technology (still in the shop).

Piel often talked of organizing lessons, units, and courses around daily newspapers. He often started speeches and workshops with the latest newspaper in hand. He could show how ninety percent of newspaper headlines, including obituaries, advertisements, editorials, and current news, could result in more questions, need for information, thinking, and evidence gathering. This is what STS is about; it is an example of using current social issues as organizers and entree to science and technology concepts and skills. Although the "Man-Made World" never captured the attention and use it deserved, several newer programs are attempts to provide similar pathways. Two middle high school programs exemplify STS and the use of social issues in science education. These are "Event-Based Science" (Wright, 2001) and Integrated Mathematics, Science—and Technology (Center For Mathematics Science and Technology Education, 1998). But, the challenge remains in making these innovative programs the choice for more teachers and schools. They can be of great help in providing ways of using social issues as "up-front" organizers and motivating contexts for K-12 science programs.

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