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ABSTRACT

This document provides an overview of the status of instruction concerning Science/Technology/Society (STS) issues in elementary and secondary history courses and makes a persuasive case for the implementation and expansion of courses addressing these issues. A quick review of research on the purpose of history of science education reveals a general consensus that it should support citizenship education and the inculcation of democratic principles. STS instruction satisfies these requirements through its focus on individual initiative, social responsibility, and the interdependence between society and technology. In addition, STS instruction often provides a chronological framework that buttresses traditional history instruction. Educators note that other goals for history instruction include engendering critical analysis, problem solving skills, appreciation for other cultures, and understanding the ideas and actions that have shaped the world. The interdisciplinary approach of STS instruction, drawing material from a wide variety of sources, supports all of these efforts. Reflecting the development and evolution of scientific and historical consciousness STS instruction also incorporates intellectual and cultural history. Nonetheless, a cursory examination of social studies curricula reveals a dearth of STS courses. Although promotion of STS education has proven popular at conferences and in the professional literature few inroads have been made at the school level. Reasons given for this shortage include the traditional (and still valid) complaint of too much content, too little time. Studies, however, indicate that STS courses are popular with students and can often serve as a gateway to introduce historical periods and themes. (MJP)

TEACHING ABOUT THE HISTORY OF SCIENCE AND TECHNOLOGY IN HISTORY CLASSROOMS:
A New Direction in STS Education

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History, in general sense, is knowledge of origins and development or evolution of contemporary matters. Whereas history is about the past, education is about the present and is concerned with improving present individuals by appropriate studies. The problem for history educators is thus how to demonstrate history's relevance to the present in a sufficiently convincing manner to gain students' interests. Concerning this point, the 1916 report of Committee on Social Studies at the National Education Association (Nelson, 1994), an instructive report even today, declared "The selection of a topic in history and the amount of attention given to it should depend .... chiefly upon the degree to which such topic can be related to the present life interests of the pupil, or can be used by him in his present process of growth" (p. 41).

However, what is happening in our history classrooms are the neglect of students' interests and the life of society. Most students seem to learn that history can help us solve problems and help us avoid mistakes. Students, however, are seldom given much help in applying these ideas. Thus, relevance to students lives often becomes a superficial justification for learning the stuff of history. In reality, history is still presented as backward extension of the political and military conflict we now hear as "news" on TV.

History has much to offer students who are striving to learn about their world and develop a sense of themselves in it. Nevertheless, according to Hoge (1988), recent studies have shown that the historical knowledge of young Americans is less than most educators and citizens would desire. Why does it happen? To answer this question, this paper examines research related to the teaching and learning of history, which especially concerns the purposes of history education, the content of history textbooks, and the status of history in our schools. In order to

do a better job of adjusting content to fit students' needs and interests, history educators have recently tried to teach new histories such as social history, women's history, ethnic history, the history of science and technology, labor history, and the like. This paper is also concerned with this new trend. However, the discussion of the whole new histories in our classrooms needs another paper. For the purpose of this paper, I examine only the research related to the adoption of the history of science and technology in history classrooms.

The significance of science and technology in our history should need no advertisement. Without science and technology, our contemporary civilization would not exist as we know it. Under these circumstances, alert students will naturally wonder about when, how, and why science and technology came to occupy this position. Nevertheless, our history courses give them few clues. The textbook's coverage of the history of science and technology is poor. In this respect our history classrooms are not concerned with students' present interests and needs. In brief, there is a disparity between the role of science and technology in our lives and its role in our history courses. Concerning the reason, Servos (1993) argues "it would be easy to say that general historians lack the technical sophistication to understand the history of science or that historians of science lack the literary skill to attract readers from the humanities. Yet neither of these arguments carries much force. Few historians have managed to evade all contact with science during their educations, and many have strong scientific credentials .... Historians ignored the history of science a generation ago because so much of it seemed so dull. In truth, it was dull" (pp. 281-283). However, most historians of science are today far closer to general historians in their values and interests than they are to scientists. Inspired by Thomas Kuhn and Robert Merton, historians of science today maintain that science is not an impersonal and

objective force that is independent of politics, values, and beliefs of its practitioners and patrons. If scientists achieve progress, Kuhn tells us, it is not because they obey special and inflexible rules but rather because they work within social structures that are unusually efficient in defining and solving problems. The science of a given age has belonged, not only to its own tradition with its own methods, values, and accumulated knowledge, but also to its own historical period, in which other movements have made their own impact upon it. Moreover, science has become one of the important determinants of the strength of any major historical movement during the twentieth century. Insofar as science holds a central place in our culture, we omit one of the essential driving forces and normative constraints in our culture if we treat science as extraneous and having no history. Concerning this point, this paper examines what researchers have told us with regard to the adoption of the history of science and technology in history courses. Besides historians of science, STS (science-technology-society) educators also have recently done research on the issue as a major theme in education on STS. I will come back to this later.

What Does Research Tell Us about the Purposes of History Education?

Thomas Jefferson long ago prescribed history for all who would take part in self-government because it would prepare people for things yet to come. William McNeill, a leading historian in the twentieth century, argued "democratic citizenship and effective participation in the determination of public policy require citizens to share a collective memory, organized into historical knowledge and belief" (Crabtree et al., pp. 3-4). Research evidence gathered for this paper indicates that history education is generally considered as the core of democratic education. In other words, without knowing the past, citizens cannot know the choices before

them.

According to the project of the National Center for History in the Schools (Crabtree et al.), the purposes of historical study must reflect the three ultimate purposes of education in a free society: "to prepare the individual for a career of work, to sustain life; for active citizenship, to safeguard liberty and justice; and for the private pursuit of happiness" (p. 2). The historians on the project argue that historical study contributes to all three, but in preparing the individual for citizenship and for personal fulfillment its offerings are unique, and together with those of literature and philosophy, are indispensable. They further note that historical memory is the key to self-identity, to seeing one's place in the stream of time, in the story of humankind. Thus, unfurnished with historical knowledge, we remain ignorant of the possibilities for personal liberation that history opens to us.

According to *Guidelines for Teaching History in Schools* (1989) by the Bradley Commission on History in Schools, without historical understanding, the two foremost aims of American education cannot be achieved - the preparation of all our people for private lives of personal integrity and fulfillment, and their preparation for public life as democratic citizens. For the first aim, personal growth, history is the central humanistic discipline. It can satisfy young people's longing for a sense of identity and of their time and place in the human story. For the second aim of education, active and intelligent citizenship, history furnishes a wide range of models and alternatives for political choice in a complicated world. Most obviously, an historical grasp of our common political vision is essential to liberty and justice in our society. The study of history should, therefore, be required of all students and be centered in social studies curriculum from the kindergarten through six grade.

Bourdillon (1994), a British historian, also emphasizes the importance of history and its centrality to citizenship and personal life. According to Bourdillon, history teaching aims to engender an understanding and respect for the individual, other people and different cultures; it also aims to develop students' ability to examine critically a wide range of social issues. Students should be empowered by this education and thus should be able to take their place in society as autonomous individuals able to make moral decisions about their lives.

Russell (1993) notes the key importance of history in developing students' critical thinking skills and their skills of enquiry and investigation. According to Russell, teaching in general is a means to entice students to question actively their own beliefs and certainties, and thus participate in their own education. The first step in doing this involves "tearing self-consciousness." The cultural/historical beliefs we have adopted help determine who we are; the extent to which we become aware of our unquestioned sociocultural assumptions is the extent to which we become creative independent individuals. In order to become free we have to have our prejudices torn. History education plays an important role here. Russell maintains that what history education should consist of is the continual confrontation with the truths and ideas that students and teachers hold self-evident, and not simply the memorization of social/cultural information about the past. Understanding the ideas and actions that have shaped the world, and putting information into a coherent story about how human beings have made their world, is the goal. In this vein, he further argues, in history education, answers are less important than questioning answers.

We do not see democracy as a way of life that can be transmitted unthinkingly to students, but one that is learned as it is questioned, thought about, criticized, and improved.

Related to this, Engle & Ochoa (1988) also hold that the democratic citizen is not to be understood merely in the classic "good citizen" sense of one who is patriotic, loyal, and obedient to the state; rather the good citizen is also a critic of the state, one who is able and willing to participate in its improvement.

In brief, the critical role of history education is to cultivate individuals who are knowledgeable, skillful, and committed to democratic values. The argument for more history in the schools and for its centrality to the social studies has usually stressed its role in preparing informed and sophisticated citizens. Much of what will happen to us in the future seems to depend on the decisions citizens make today. According to Murchland (1983), over 50 percent of all political decisions are now technical in nature; this is equally true of ethical decisions. Science and technology present democratic societies with certain challenges. The democratic tradition of majority rule is threatened by massive ignorance about public issues related to science and technology. In this sense, currently, the distinction between social and scientific issues is not sharp. Scientific and technological literacy and civic literacy have become symbiotic. In other words, exercising our civic responsibilities requires an increasing level of scientific and technological competency and a knowledge and understanding of the interdependence and interaction among science, technology, and society.

In my view, the current preoccupation of Americans generally with the influence of science and technology on their lives accounts to a large degree for the fascination of public school and educators with the history of science and technology. For example, National History Standards Project (1993) by National Center for History in the Schools considers the inclusion of the history of science and technology as one of the "Criteria for National Standards in

History": "standards in U.S. and world history should integrate fundamental facets of human culture such as religion, *science and technology*, politics and government, economics, interactions with the environment, intellectual and social life, literature, and the arts" (p. 34).

Marcus (1989) also notes, in *Magazine of History* (MOH devoted, in the spring issue of 1989, a considerable part to the topic regarding the inclusion of the history of science and technology in history classrooms), that political systems, *technologies*, art and virtually every other public activity that took place at a specific time in the past, have an underlying unity, and the disclosure of the nature of that unity is an important task in historical study. Therefore, in my view, we need to rethink about the content of current history textbooks, which still reflects mainly political aspect of history. What history then should be taught?

What History Should Be Taught?

Concerning what history to teach, the project of the National Center for History in the Schools states "we must hope that the American educational debate has moved to a higher stage, that we have left behind the futile dialogue between "content" people and "methods" people" (p. 10). Historical understanding requires both knowledge of facts and ways of thinking about facts. Regarding the question of the essential content, both factual and conceptual, we need to reconsider about what are the major historical themes that all of our students should explore, those larger developments without which they will not understand themselves or their society, or the larger world outside.

George Counts' examination of American civilization affirmed two essential strains: an egalitarian democratic ethic and the emergence of a scientific-industrial-technological society.

These two strains are probably the elements that have become the basis of our civilization. While numerous scholars talked about the preservation of democratic value through history education, a few people were concerned with the topic related to the latter. In my view, we need to understand not only our moral and political heritage but also the scientific and technological aspects of our history.

Heath (1989), a leading STS educator, argues that social studies curriculum should include a historical to present-day perspective on relationships of scientific and technological effects to the development of society. He further maintains "ability to connect information and ideas within and between academic disciplines and to link different fields of knowledge is a key to high-level understanding of social reality" (p. 61). In fact, citizens of a modern constitutional democracy can neither perceive current events and issues accurately, nor think clearly about them, nor act responsibly and effectively on them unless they know about science and technology as powerful cultural forces that have shaped the critical events and issues. In this vein, students should understand more *fully* their own civilization.

Marcus (1989) also emphasized the importance of intellectual and contextual history in history education. According to Marcus, any particular time in the past is explainable or understandable only with its unique intellectual context. If this sense of context is to serve as the principle around which to organize the study of past times, then the history of science and technology will remain a vital part of history curriculum. Because it would serve as an integral facet of the study of past times.

Servos (1993) notes that science has as long and as meaningful a part in the Western tradition as, for example, religion or art. According to his analysis, science and technology

dramatically transformed our society during the late nineteenth and twentieth centuries, but the nature of science and the way in which it accomplished these results seemed so mechanical and so obvious as to be historically uninteresting. In Servos' view, this partly explains the omission of the history of science and technology from history textbooks. Additionally, Servos points out that during the past 30 years, all of the simple and seemingly self-evident verities have been called in question by historians and philosophers of science and by historians of technology. Under these circumstances, the teaching of the history of science and technology should occupy an important place in history classrooms.

Related to this point, Jacob (Appleby, 1994), a leading historian of science, also argues "teaching science to examine its biases as well as its truths, its arrogance as well as its elegance, would enrich the public as well as scientists and humanists because both participate in similar systems of knowledge construction and both are utterly dependent upon the vitality of civil society for the rigor, originality, and competitiveness of their theories and practices. Similarly, where democratic ideals and practices have faltered in either the community of the arts or that of the sciences, their critics rightly sound the alarm and proclaim the need for renewal within the republic of learning" (p. 283).

In fact, science was seen as a logic machine that worked according to its own laws. It was objective and impersonal; it stood above and beyond the realm of human action. Science was also believed to be progressive in ways that other human enterprises were not because it transcended the foibles and stupidities of individual actors. Now, however, we realize that science no longer tells us absolute truth. According to the recent scholarships in the sociology of science, science and technology are activities that involve human values. Characteristics of

persons engaged in scientific inquiry and technological problem solving are linked to the values, attitudes, and assumptions of their enterprises. What 'does' and 'does not' count as 'science' depends on the social meaning given to science, which will vary not only historically and cross-culturally but within societies and situationally. The dominant English definitions of science might be characterized as what Jergen Habermas calls "objectivistic", by which he means that we accept the scientists' claim that they "apply their method without thought for their guiding interests." To put it in another way, an idea of science has developed in which what is thought of as scientific knowledge is abstracted from that institutional contexts in which it is generated and used. In this sense intelligibility is inseparable from its linguistic-cultural use. Therefore, we can say that knowledge is socially-culturally constructed. Students could, through the study of the history of science and technology, recognize the value in diversity of ideas and a commitment to remaining open-minded in confronting competing ideas. And thus they could understand knowledge is continually in the process of reconstruction, and consider 'academic knowledge' as 'given' or 'problematic' rather than 'to be explained.'

In this vein, students could, through the study of the history of science and technology, expect to learn a truth-seeking and thus ever-expanding history which takes a collective effort. A culture is not an aggregation of discrete, separate items; it is rather a system of relationships which responds to interior and exterior stresses and strains and continually alters social patterns. In this context, it makes little sense to array the history of science and technology opposite general history along C. P. Snow's two-culture divide.

Furthermore, it is generally acknowledged that the history of science and technology opens up another range of awareness by demonstrating that peripheral societies must be

examined with equal seriousness if we are not to overlook real originality. Through the study of the history of science and technology, students would ask if it is possible that science is not fundamentally Caucasian and Judeo-Christian after all. Cases from the past would make accessible gradual reorientation of value that help students learn what to look for, how to see past our prejudices and preconceptions. This history could be defined as multicultural and synthetic history. Knowledge of history is the precondition of political intelligence and of intellectual autonomy. In studying history we are talking about consciousness as it evolves in time. As Laville & Rosenzweig (1982) maintain, we should prefer "a history which represents an approach to knowledge and a method by which to question, to interpret, and to know the social facts of the past and present" (p. 63). However, in reality, teaching history as a collection of facts and concepts as *truths* provides little opportunity for questioning or valuing.

What Is the Status of History in Our Schools?

Downey (1985) nicely summarizes, in his report to the National Endowment for the Humanities, the status of history in our schools. With little current data available from the schools, this report depended almost entirely on previously published information. He notes that history education is a major enterprise in the public schools, consuming substantial time and money. Its status should be of more than passing interest to anyone concerned about the state of public school education in the United States.

While U.S. history in both the junior and senior high schools is customarily taught as an independent subject, world history is sometimes taught as an integrated course in history and geography called World Cultures. At the high school level, the integrity of the several disciplines

involved in the social studies is usually preserved in a federated rather than integrated curriculum. According to Downey, the content of the U.S. history textbooks used in the secondary schools is similar to that of the standard college history texts. U.S. history courses in the schools are repetitious, especially at the secondary level. The U.S. history textbooks written for junior high schools students tend to be condensed versions of high school textbooks built around a core of political and economic history. In brief, an examination of secondary school textbooks reveals a great deal of overlapping content. The content does not deal with tangible aspect of history.

In my view, history courses, at all levels, are usually conceived as conveying a specific subject matter rather than fostering a way of thinking about the past. In fact, there are many things wrong with the study of history: repetitious drilling from a single textbook, a superficial recall of facts quickly forgotten, courses whose content was too thin because they tried to cover too much, and the consequent boredom of most students who have no personal interest in history. This kind of history education needs to be rooted out of the schools.

Besides, what became major themes in a sequential, chronological, and narrative national historiography for young people is still territorial expansion, economic development, and social reform. Despite the universal lip service paid by historians to the special role of science and technology in the development of Western culture during the past four centuries, the history of science and technology is for most of them still foreign territory. Concerning this point, Kuhn (1977) points out "taken in conjunction with the few traditional examples used to illustrate them, they [general historians] often exaggerate and regularly distort the nature, extent,and timing of the sciences' role .... perhaps the most striking is the almost total neglect of scientific

development since 1750, the period during which science assumed its main role as a historical prime mover" (p. 128). Herbert Butterfield (1957), a leading general historian, staked out a dramatic claim for the part played by science over the last five centuries in shaping Western society. In his view, the Scientific Revolution of the sixteenth and seventeenth centuries "outshines everything since the rise of Christianity and reduces the Renaissance and Reformation to the rank of mere episodes, mere internal displacements, within the system of medieval Christendom" (p. vii). Then, in reality, how do our history textbooks deal with the ideas of the Enlightenment? According to Gagnon's analysis (1987), regarding the topic, Newton gets one line ("Newton developed our concept of gravity") at the end of a single paragraph headed "Science during the Renaissance." There is nothing else on the Scientific Revolution of the seventeenth century or on the intellectual revolution of the eighteenth century (p. 77).

Unlike other new histories such as women's history, social history, and Afro-American history, the history of science and technology has not drawn much attention to be covered in our history classrooms. Regarding this point, Glenn & Genaro (1987) note that teachers believed there was just too much basic content to cover to have any time left for new topics. This belief suggests that the movement toward the adoption of the history of science and technology in history courses will not be an easy one. However, if we remember that history courses in the schools are repetitious, we could find enough room for the new area in current textbooks. In fact, according to Downey (1985), the concern about repetition of course content probably is the major reason for the apparent decline of U.S. history in the junior high schools. Downey further holds that the basic flaw is not repetition; it is the repeated encounter with a history that has little meaning to students struggling to learn it.

Whether the integration of the history of science and technology and general history subjects is detrimental to history instruction depends largely upon how the mixing of subjects is accomplished. History is by nature a synthesizing discipline. As all education is concerned with the promotion of knowledge and understanding in some form, the history of science and technology has wide relevance to education. To think seriously about the promotion and validation of human knowledge without trying to understand the historical aspect of science and the scientific aspect of society is impossible. The inclusion of history of science and technology does not, of course, provide all the answers to the present history education problems. However, I believe it has a contribution to make to the overall task of improving history teaching and learning. I discuss it in the following section.

Is the History of Science and Technology Likely to Help Students Develop Knowledge and Interest in History?

The inclusion of the history of science and technology in a school subject - not necessarily in history - has generally been discussed by STS educators and historians of science. This section examines what researchers tell us about the adoption of the new area. The researchers' common assumption here is that the good citizen today should understand the 'connectedness' of things as well as peoples. We often talk of the inevitability of global citizenship as technology slowly turns our world into a global village, but we rarely deal with what that means to us as citizens. Seeing the 'connectedness' of things as well as peoples is the goal of common learning. The magnitude and complexity of issues in our contemporary society require an understanding of relationships as well as facts. The study of STS in general gives an

understanding of the interconnectedness of science-technology-society. Thus, through this study, the study of history in itself could become a powerful tool for making meaning of today's world and a practical means of forging decisions which will shape the world of tomorrow.

STS (Science/Technology/Society) Education is defined as an education for the understanding of how science and technology shape and are shaped by society, the problems and opportunities they create, and how citizens can relate most effectively to them. As a movement in the United States, STS is less than twenty years old. According to Patrick (1984), it has become trendy to proclaim the new goals of STS Education at conferences and in professional journals, but it has not yet become a national trend in the curricula of our schools. Although national associations (National Council for the Social Studies and National Science Teachers Association) and educational leaders have called for including STS in educational programs, such recommendations are not always implemented. Since the mid-1980s, according to Giese et al. (1991), two textbooks incorporating the STS theme have been published for use in full-year science courses, while no comparable social studies textbooks are currently available. And little is known about the actual teaching of STS topics in social studies and science. Concerning the barriers to a more rapid inclusion of STS content, Marker (1993) advances five hunches: the crowded curriculum, lack of curriculum resources, controversial characteristic of STS issues, teacher's discomfort with science, and low status for high technology. The discussion regarding the barriers to STS, however, is beyond the purpose of this paper.

Even under these circumstances, STS was deemed important. The *Handbook of Research on Social Studies Teaching and Learning* (1991) devoted a chapter to the topic. That chapter provides both a current assessment of the status of research on STS and suggestions for future

investigations. Recognizing the importance of the connection between science, technology, and society, various journals devoted a considerable part to STS, including the 1990 issue (vol. 54) of *Social Education*, three issues of *Theory into Practice* (Kowal, Rubba, and Marker, 1991 and 1992), and the 1989 spring issue of *Magazine of History* (Marcus and Heath). Especially the last one is concerned with the inclusion of the history of science and technology in history and social studies. And additionally, Social Science Education Consortium published some books related to STS: *Teaching About the History and Nature of Science and Technology* (1992), *Science, Technology, Society: A framework for curriculum reform in secondary school science and social studies* (Patrick et al., 1987), and *Connecting Science, Technology, and Society in the Education of Citizens* (Patrick & Remy, 1985). Most of these STS literature has been devoted to advocating STS as a reform in social studies and science education and to discussions of what ought to be included in STS programs. While social studies educators have contributed to the rationale for STS education, there is virtually few research on how STS is perceived, taught, or learned in social studies. Research on STS education has been conducted almost exclusively in science education.

According to the findings from several survey studies (Barrow & Germann, 1987; Barman et al., 1982; and Bybee & Bonstetter, 1987), about 90 percents of the teachers in the studies said they would incorporate the STS theme if materials and instructional strategies were available. Many want to reserve judgment on STS Education until they see a curriculum and some concept focused goals and assessment instruments. Heilbron and Kevles (1988), both leading historians of science, were concerned with "SciTech" issues in history textbooks. In their view, the present skimpy coverage of the history of science and technology in our textbooks

suffers not only from wide dispersion of material but also from capricious or inconsistent development. They suggest several ways to promote coherence. In fact, they argue, recent developments in the history and sociology of science and technology make the more ambitious restructuring of history textbooks more practicable. Now we have on hand more than enough material for the needs of textbook writers, and historians of science and technology appear to be prepared to offer more than their research output. At this point, we need to plan ways to disseminate the historians' research results more widely. How could we do that?

The vitality of the scientific tradition in history, and its positive impact on society, depends on students being successfully introduced to its achievements, methods and thought processes, by teachers who understand and value science within history. In this regard, we need to rethink about preservice and in-service history and social studies teacher education. Additionally, we need to investigate what are the factors influencing the adoption, implementation, and institutionalization of the new area, broadly STS.

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