A 2009 Report on Technology Education in the United States

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Introduction

This paper presents a report on the current status of technology education in the United States (U.S.). The main points that are discussed are: the recent decade of creating and implementing nationally-developed Standards for Technological Literacy (ITEA, 2000, 2002, 2007) in the U.S.; a movement towards incorporating technology and engineering in the study of technology in grades PK-12; teaching technology and the workforce; and positioning the study of technology within education in the U.S.

A Decade of Standards for Technological Literacy: Evolution of Educational Standards in the United States

Nationally-developed educational standards in the United States have been produced that provide a better understanding of what every student should know and be able to do in order to become literate. The development and use of these educational standards have been instrumental in influencing the direction and progress of education at the national, state, and local levels. These nationally-developed standards began being released in the late 1980s and continued through the beginning of the 21st century. Educational standards evolved from and were a result of some discontent for the quality of public education in this country. The discontent began with a report from the National Commission on Excellence in Education formed by the US Department of Education in the "A Nation at Risk" in 1983. In the late 1980s and 1990s, virtually every area of study in schools created national standards for what all students should know and be able to do in their

subject matter. There were two sets of nationally-developed standards in science and all the other subject areas completed one set of standards. Other school subject areas that were prominent in the national standards movement in the 1980's and 1990's were history, English/language arts, art, physical education, mathematics, and others. The mathematics standards were the first to be produced in 1989 by the National Council of Teachers of Mathematics (NCTM). After the NCTM standards were produced, the American Association for the Advancement of Science (AAAS) released a set of standards for science titled, Project 2061 *Benchmarks for Science Literacy* (*BSL*). The second set of nationally-developed standards in science were produced by the National Research Council in its document, *National Science Education Standards* (*NSES*) (1996). Many other subject areas developed national standards in the 1990's and early 2000's. The International Technology Education Association received funding from the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) to develop Standards for Technological Literacy (STL) from 1994 to 2005.

Standards for Technological Literacy: Content for the Study of Technology

ITEA, through its Technology for All Americans Project (TfAAP), produced a significant publication titled *Technology for All Americans; A Rationale and Structure for the Study of Technology (R&S)* from 1994 to 1996 (and did a comprehensive revision of this document in 2006). The R & S document provided the research necessary to identify the content to be later used in the creation of STL standards.

Standards for technological literacy were developed by the International Technology Education Association (ITEA) from 1996 to 2000. These include *Standards for Technological Literacy: Content for the Study of Technology* (*STL*) (2000/2002/2007), which established the content in a standards format for what every student should know and be able to do in order to be technologically literate.

The vision of *Standards for Technological Literacy* is that <u>all</u> students can and should become technologically literate. So what is technological literacy? ITEA defines it as one's ability to use, manage, evaluate, and understand technology. Technological Literacy can be viewed as furthering the study of technology, innovation, design, and engineering. Technological literacy is more of a capacity to understand the broader technological world rather than an ability to work with specific pieces of it (NAE & NRC, 2002, p. 22).

The standards and benchmarks in *STL* and the standards and guidelines in *AETL* were created with the following goals:

- They offer a common set of expectations of what students should learn in the study of technology.
- They are developmentally appropriate for all students in Grades K–12.
- They provide a basis for developing meaningful, relevant, and articulated curricula at the local, state, and provincial levels.
- They promote content connections with other fields of study in Grades K–12.
- They encourage active and experiential (hands-on) learning.

Some of the characteristics of *STL* are:

- There are five categories under which 20 standards are:
    - The Nature of Technology
    - Technology and Society
    - Design
    - Abilities for a Technological World
    - The Designed World

- Under the 20 standards, there are approximately 290 benchmarks that provide further elaboration and detail to each of the standards.
- The benchmarks in *STL* are organized by grade cluster (K–2, 3–5, 6–8, and 9–12).

In addition to STL, *Advancing Excellence in Technological Literacy* (*AETL*) was developed by ITEA from 2000 to 2003. AETL has three sets of standards within its organization that address: (1) student assessment standards, (2) professional development of teachers of technology standards, and (3) technology program standards.

TfAAP/ITEA next created three Addenda for STL and AETL from 2003 to 2005. These provide assistance for implementing standards-based technology programs, student assessment, and curriculum. They feature practical suggestions and processes, multiple forms and worksheets, and concrete examples for implementing exemplary technology education programs and curriculum in grades K-12.

Anyone who wishes to read or preview the documents of STL, AETL, and the Addenda can view them in their entirety by going to the ITEA Webpage at www.iteaconnect.org.

ITEA/Gallup Polls

In 2001 and 2004, the International Technology Education Association (ITEA), in conjunction with the Gallup Organization of Princeton, New Jersey, conducted polls on "How Americans Think About Technology". In the 2001 survey, 1,000 telephone interviews were conducted of a national, general population sample of adult men and women, ages 18 and over. In the 2004 survey, the sample size was 800. The results from these two surveys are:

- In both polls, a majority of Americans (62% in 2004, 59% in 2001) responded that science and technology is basically one and the same thing.
- When asked in the 2001 poll how important it was for high school students to understand the relationship between science and technology, 98% stated that it was very or somewhat important.
- Most Americans (68% in 2004, 67% in 2001) view technology narrowly as being computers, electronics, and the Internet. This was the result of an open-ended question that was provided to the respondents in which they had to verbally tell the telephone interviewer what they thought technology was.
- There was near total consensus in both polls (98% in 2004, 97% in 2001) of the public sampled that schools should include the study of technology in their curriculum.

As it has been documented in the ITEA Gallup Poll, there is mass confusion about what science and technology are in the United States. If this finding is true, then what is the best thinking of our time as to what science and technology are? This is presented in the next four paragraphs:

Science, which deals with and seeks the understanding of the natural world (NRC, 1996, p. 24), is the underpinning of technology. Rodger Bybee, President of the Biological Sciences Curriculum Study (BSCS), explains more about science and technology.

> A lack of technological literacy is compounded by one prevalent misconception. When asked to define technology, most individuals reply with an archaic and most erroneous idea that technology is applied science. Although this definition of technology has a long standing in this country, it

> is well past time to establish a new understanding about technology. It is the interest of science, science education, and society to help students and all citizens develop a greater understanding and appreciation for some of the fundamental concepts and processes of technology and engineering. (2000, pp. 23–24)

Science is very concerned with what is (exists) in the natural world. Many of the courses in schools, colleges, and universities reflect this natural world inquiry. These courses deal with biology, chemistry, astronomy, geology, etc. Some of the processes that are used in science to seek out the meaning of the natural world are "inquiry," "discovering what is," "exploring," and using "the scientific methods."

Technology, on the other hand, is the modification of the natural world to meet human wants and needs (ITEA, 2000, p. 7). This definition is comparable with the definition provided in the *National Science Education Standards* which states, "The goal of technology is to make modifications in the world to meet human needs" (NRC, 1996, p. 24). Similar to these definitions, the American Association for the Advancement of Science (AAAS) *Benchmarks for Science Literacy* presents the following: "In the broadest sense, technology extends our abilities to change the world; to cut, shape, or put together materials; to move things from one place to the other; to reach further with our hands, voices, and senses" (1993, p. 41). In the National Academy of Engineering (NAE) and the National Research Council (NRC) publication, *Technically Speaking*, *Why All Americans Need to Know More About Technology*, technology is described as "…the process by which humans modify nature to meet their needs and wants" (2002, p. 2). All of these nationally recognized definitions of technology in the United States are very similar and reinforce each other. Technology is very concerned with what can and should be designed, made, and developed from the natural world materials and substances to satisfy human needs and wants. Some processes used in technology to alter and change the natural world are "invention," "innovation," "practical problem solving," and "design."

ITEA's Engineering by Design

The International Technology Education Association's Center to Advance the Teaching of Technology and Science (ITEA-CATTS) has developed the only standards-based national model for Grades K-12 that delivers technological literacy. The model, Engineering by Design™ is built on *Standards for Technological Literacy* (ITEA); *Principles and Standards for School Mathematics* (NCTM); and *Project 2061, Benchmarks for Science Literacy* (AAAS).

Built on the constructivist model, students participating in the program learn concepts and principles in an authentic, problem-based environment. A network of teachers (EbD™ Network) has been selected to collaborate and conduct action research in order to better understand the complexities of student learning and to help all students succeed and be prepared for the global society in which they will grow up.

We live in a technological world. Living in the twenty-first century requires much more from every individual than a basic ability to read, write, and perform simple mathematics. Technology affects every aspect of our lives, from enabling citizens to perform routine tasks to requiring that they be able to make responsible, informed decisions that affect individuals, our society, and the environment.

The mission of Engineering by Design is that citizens of today must have a basic understanding of how technology affects their world and how they exist both within and around technology. Technological literacy is fundamentally important to all students. Technological processes have become so complex that communities and schools should collaborate to provide a quality technology program that prepares students for a changing technological world that is progressively more dependent on an informed, technologically literate citizenry.

The vision of Engineering by Design is that ITEA model technology programs are committed to providing technological study in facilities that are safe and facilitate creativity, enabling all students to meet local, state, and national technological literacy standards. Students are prepared to engage in additional technological study in the high school years and beyond. Students will be prepared with knowledge and abilities to help them become informed, successful citizens who are able to make sense of the world in which they live. The technology program also enables students to take advantage of the technological resources in their own community.

The National Assessment of Educational Progress for Technological Literacy

For the first time ever, technological literacy will be part of the National Assessment of Educational Progress (NAEP), also known as The Nation's Report Card™. The first step toward this unprecedented assessment was announced in 2008 by the National Assessment Governing Board, which awarded WestEd a

contract to develop the 2012 NAEP Technological Literacy Framework. Under this new contract, awarded after a competitive bidding process, WestEd – a national education research and development organization based in San Francisco – will recommend the framework and test specifications for the 2012 NAEP Technological Literacy assessment. Ultimately, this task will lead to ways to define and measure student's knowledge and skills in understanding important technological tools. Governing Board members will then decide which grade level – 4th, 8th, or 12th – will be tested in 2012.

The NAEP Technological Literacy Assessment is the country's first nationwide assessment of student achievement in this area. The work comes at a time when there are no nationwide requirements or common definition for technological literacy. Few states have adopted separate tests in this area, even as more business representatives and policymakers voice concern about American student's abilities to compete in a global marketplace and keep up with quickly evolving technology.

Several groups are assisting WestEd for this 18-month project, including the Council of Chief State School Officers, the International Technology Education Association, the International Society for Technology in Education, Partnership for 21st Century Skills, and the State Educational Technology Directors Association. With this assistance, WestEd plans to convene two committees that will include technology experts, engineers, teachers, scientists, business representatives, state and local policymakers, and employers from across the country. The committees will advise WestEd on the content and design of the assessment and make recommendations to the Board on the framework and specifications for the 2012 NAEP Technological Literacy Assessment. In addition, hundreds of experts in various fields and the general public will participate in hearings or provide reviews of the framework document as it is developed. Ultimately, the collaboration will reflect the perspectives of a diverse array of individuals and groups. The Governing Board is slated to review and approve the technological literacy framework in late 2009. (Christian Science Monitor, 2005)

Technology and Engineering Education

A new movement in education in the U.S. is the integration of the subjects of science, technology, engineering, and mathematics known as STEM. The "E" in STEM represents engineering while the "T" in STEM stands for technology. It is relevant to know that technology education (the study of technology and previously called industrial arts) started about a century and one half ago through involvement with engineering in some major colleges in the U.S. Technology

education has taught engineering drawing and engineering design for decades in the U.S. At least two states (Virginia and New York) created high school curricular that teaches engineering at grades 11-12 (ages 16-17).

If one accepts the similar definitions that "technology is the process by which humans modify nature to satisfy their wants and needs" (NAE, 2002) or "technology is the modification of the natural world to meet human needs and wants" (ITEA, 2000, 2002, 2007), then engineering must be determined to be a part of technology. The Accreditation Board for Engineering and Technology (ABET) defines engineering as: "the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind" (ABET, 2007).

In developing STL, the engineering profession was very involved. Dr. William Wulf, President of the National Academy of Engineering (NAE), served as a very active and influential member of ITEA's Technology for All Americans Project's Advisory Board. Dr. Wulf wrote the foreword in the STL document. The NAE provided a formal letter of support to STL when it was released in 2000. Additionally, the NAE and the NRC gave recommendations for members of a Technological Literacy Standards Review Committee that reviewed STL in its development. There was also a NAE Focus Group that guided STL throughout all of its eight drafts to ensure that the content was accurate and appropriate for K-12 schools in the U.S. This Focus Group was composed of some of the top engineers in America. In the last time period of developing STL (1999-2000), the NAE provided assistance in organizing a special panel of 17 engineers and others who gave detailed input into the content and organization of STL. Finally, a number of engineers were included in the review and validation of STL through public hearings, electronic document review, and by mail. In summary, the engineering profession was extensively involved in the process and product of STL.

There is a growing need for engineers in the U.S. (Clayton, 2005). Industry and business have more positions available for engineers than there are graduates emerging from universities. The increase of the number of graduates in engineering in China and India add to concern about the production of engineers in the U.S. The need for engineers, as viewed by some people, provides an opportunity for expanding engineering education down into the public school curriculum in grades K-12 as a recruiting tool. As it has already been stated, technology education already teaches many basic engineering concepts in such programs as ITEA's Engineering by Design (EbD) and Project Lead the Way.

As with most things in life, there are at least two sides to every story. The inclusion of the study of engineering in grades K-12 schooling in the U.S. may create opportunities as well as cause problems. The concepts and content of engineering could be appropriate for only a few rather that be appealing and beneficial to all students. Additionally, change happens very slowly in education, so the acceptance of engineering as a subject matter along with other subjects such as the study of technology in the STEM integration process could be a major uncertainty. Another problem is the lack of coherence between technology education and engineering in schools (grades K-12).

In summary, there are opportunities as well as problems related to the "T' and "E" in STEM as being deliverers of needed and acceptable content alongside their partners of "S" and "M" in an integrated approach to education for all students in the future.

Teaching Technology and the Workforce

Technology education is still considered as part of general education in many states in the U.S. If one truly believes that a study of technology is so important that all students should be required to learn about and be able to do technology, then technology education should be a required subject for every student. This requirement includes those students going to college after high school graduation as well as those students going into career and technical education (vocational education) jobs after graduation. Currently, in most states, this basic, core, or required education only includes language (reading and writing English), mathematics, science, and social studies (history). Technology education is not a required subject matter in the majority of states.

There is confusion today in the U.S. between the terms "technology" and "technical". Many citizens believe that they are the same. Because of this confusion, technology education is often considered as being vocational education. This problem is further compounded when many technology educators say that they teach "tech Ed". In this misunderstanding of words, does "tech" mean technology or technical?

Although technical education is being offered in some public high schools today, technical skills in the U.S. are mostly being taught at the community college level (2 years beyond high school graduation). Also, there are numerous privately owned

technical training institutions that offer associate degrees or certificates in technical education.

Positioning the Study of Technology Within Education in the U.S.

Education in the U.S. is the responsibility of each state. Education is not a national responsibility although in the past decade "No Child Left Behind' legislation has resulted in the federal (national) level assuming more responsibility for education. Each state has its own set of guidelines of what technology is within a given state. These guidelines include the level of support provided by the state to local (county, city, parish, etc.) school districts. In some cases, the level of support is 50% or more which makes education in that state primarily state controlled while in other states the level of funding from the state to local school districts is less than 50% making education a local responsibility. These state guidelines also include the responsibility of who develops standards as well as who maintains the philosophy for teaching and learning.

An effort has just begun in the U.S. to establish new national standards in mathematics and reading for the whole country. Other new national subject matter standards will be developed and validated in the future. As was stated earlier in this paper, the first nationally developed standards were created in the 1980's and 1990's. They were designed to provide unified content for subject matter areas such as STL identified content for what should be taught and learned to be technologically literate in grades K-12 in America's schools.

The general public (ITEA/Gallup Poll, 2001 & 2004) as well as the U.S. Department of Education view technology from a narrow perspective, which includes information and computer technology (ICT), computers, media, or education technology. Technology education is not understood well by the general public and many people think that it prepares students to be only computer literate. ICT primarily deals with using technology and it is not concerned with invention, innovation, design, or making that is included in a broader understanding of technology.

Technology education does not have the same status as mathematics and science in the U.S. schools today. Moreover, curriculum development for programs and courses in technology is no longer being developed at the local, state, or national levels of education in the U.S.

The number of teacher preparation colleges and universities continue to decline in numbers in the U.S with the average number of graduates being produced each year from 2004 to 2009 being 306 graduates (Moye, 2009). The latest research about the status of technology education in the U.S. shows that the number of technology teachers is declining and in 2008-09 there were approximately 28,310 technology teachers at the secondary school level in the U.S (Moye, 2009). There is no current data on the number of students taking technology courses in America's schools today.

Summary

This paper presents a report on the current condition of technology education in the U.S. While many positive accomplishments have been made in the past, much more needs to be done in the future if the mission and goals of our profession are to be met. In many respects, the American public believes that the study of technology is needed in our schools now and in the future (ITEA/Gallup Poll, 2004). Unfortunately, what people believe and what happens as a result of this belief is not always the same. As a result, the study of technology in the U.S. faces an uncertain future.

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URL's of Interest:

STL, AETL, Addenda, and Video about the ITEA Standards Publications— International Technology Education Association (ITEA): Webpage URL: www.iteaconnect.org

NSES—National Research Council (NRC): www.nap.edu

BSL—American Association for the Advancement of Science (AAAS): www.aaas.org

Mathematics Standards --National Council of Teachers of Mathematics (NCTM): www.nctm.org

Accreditation Board for Engineering and Technology (ABET): www.abet.org