

# **Twenty Years of Educational Standards for Technology Education in the United States**

## **A Paper for the 2005 PATT Conference**

**By**

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Educational reform in the United States over the past decade and a half has been driven by educational standards. All major subject matter areas (approximately 15) have developed educational standards at the national level. Also, every one of the 50 states as well as some local school districts have developed standards. This paper will present a historical overview of all of the educational standards developed and implemented in technology education in the United States over the past quarter of a century.

### **In the Beginning**

Our profession created its first set of *Standards for Industrial Arts Programs* (Virginia Tech, 1981), made possible through a grant from the U.S. Department of Education. This was later revised to reflect a more contemporary focus in 1985 as *Standards for Technology Education Programs* (International Technology Education Association, 1985). The later revision was funded by the Technical Foundation of America (TFA) and distributed by ITEA. These were program standards and they provided criteria for such topics as philosophy (of the program), instructional program (curriculum), student population served, instructional staff, administration and supervision, support systems, instructional strategies (methods), public relations, safety and health, and the evaluation process.

In the late 1980s and early 1990s, there were major national efforts evolving in this country to develop educational standards in a number of subject areas in K-12 schools. This began with the National Council of Teachers of Mathematics (NCTM) publishing *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989). This was subsequently followed by *Professional Standards for Teaching Mathematics* (NCTM, 1991) and *Assessment Standards for School Mathematics* (NCTM, 1995).

In 1990, the American Association for the Advancement of Science (AAAS) printed a visionary document on the rationale and need for science literacy in the U.S. schools titled, *Science for All Americans* (AAAS, 1990). It was followed by *Benchmarks for Science Literacy* (AAAS, 1993). The National Research Council produced a parallel set of science standards in 1995 in the document titled, *National Science Education Standards* (NRC, 1995).

In the last half of the 1990s, there were numerous other subject matter standards created and published in social studies, history, geography, art, English, physical education, business education, and others.

### **Creating a Vision for What *Standards for Technological Literacy* Should Be**



In the first funded phase of TfAAP, ITEA wanted to develop a document that would discuss the power and promise of technology in our lives today. It wanted to also establish a universal need of technological literacy for all people. This was very important since the study of technology in America's schools was a relatively new educational effort. ITEA did this in a two-year project from 1994 to 1996 through the publication of *Technology for All Americans: A Rationale and Structure for the Study of Technology (R&S)* (ITEA, 1996). This document provided a structure for what the content in the study of technology could be in the future.

In retrospect, the development of *R&S* was a very valuable tool in grounding the profession in what every student should know and be able to do in order to be technologically literate. The *R&S* document was prepared through assistance from project staff and a group of writing consultants made up from a 25-member National Commission for Technology Education. In developing the various drafts of the document, hundreds of practitioners of technology, engineering, science, mathematics, and other areas served as reviewers of this material.

### ***Standards for Technological Literacy: Content for the Study of Technology***

From 1996 to 2000, *Standards for Technological Literacy: Content for the Study of Technology (STL)* was developed, reviewed, published, and disseminated. *STL* sets forth the vision that all students can and should become technologically literate. Four groups advised and provided input to TfAAP during the development of *STL*—(1) the Advisory Group, (2) the Standards Team, (3) a committee of the National Research Council of the National Academy of Sciences, and (4) a focus group from the National Academy of Engineering. The Advisory Group advised ITEA in the best practice for standards development and determined ways for the study of technology to be integrated within the total school curriculum. Key representatives of the National Council of Teachers of Mathematics (NCTM), the National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS) Project 2061, the National Research Council (NRC) that developed the *National Science Standards*, the National Academy of Engineering (NAE), ITEA, and the Foundation for Technology Education formed the Advisory Group for TfAAP. They met semiannually to provide specific advice on the development of the standards, and how technology education could be integrated with other fields of study, especially science and mathematics.

The Standards Team proposed, evaluated, and recommended the content of the standards. TfAAP used a 27-member Standards Team comprised of 3 subteams with 9 people each (one team for Grades K-5, one team for Grades 6-8, and one team for Grades 9-12) to provide input to TfAAP staff who were responsible for the writing, generating, and consensus-building process of the standards. The team was made of classroom teachers, supervisors, and teacher educators from technology education as well as elementary administrators and representatives from science, mathematics, and engineering.

In 1999 and 2000, the NRC of the National Academy of Sciences (NAS) and a special focus group of engineers from the NAE were also involved in the formal review of *STL*. In mid-December 1999, the NRC committee issued a final report stating that ITEA/TfAAP had “successfully completed the review process established by the NRC.” In early 2000, the NAE committee issued a public statement in support of *STL*. Additionally, the project received funding from the Technical Foundation of America in the development of three standards-related implementation publications for the elementary, middle, and high schools.

### *Overview of the Standards Document*

The document begins with a preface that sets the stage for the publication. Chapter 1 provides a broad perspective on preparing students for a technological world. Chapter 2 contains the overview of the features of *STL*, as well as its format. Chapter 2 also provides a section that deals with the primary users of the standards, as well as recommendations for using the standards for curriculum development. Lastly, Chapter 2 lists administrator guidelines for resources based on *STL*. Chapter 3 through 7 contain major categories under which the standards were developed. Lastly, Chapter 8 is a call to action regarding how ITEA can acquire help from others within and outside of the profession to adopt implementing *STL*. The document also has an appendix, which includes the history of the project, a compendium that provides a quick overview of the standards and related benchmarks, and an articulated curriculum example for Grades K-12, as well as references, acknowledgements, a glossary, and an index.

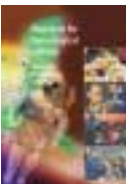
### *Features of STL*

*Standards for Technological Literacy: Content for the Study of Technology (STL)* represents the collective view of hundreds of people regarding what should be the content for the study of technology in Grades K-12. In order to be as broadly valuable as possible, *STL* was created with the following basic features:

- It offers a common set of expectations for what students in technology should learn.
- It offers specific details about what every student should learn about technology.
- It is developmentally appropriate for students.
- It provides a basis for developing meaningful, relevant, and articulated curricula at the local and state/provincial levels.
- It promotes content connections with other fields of study in Grades K-12.

*STL* is not a curriculum. A curriculum provides the specific details of how the content (*STL*) is to be delivered, including organization, balance, and the various ways of presenting the content in the classroom, while standards describe what the content should be. Curriculum developers, teachers, and others should use *STL* as a guide for developing appropriate curricula, but the standards do not specify what should go on in the classroom.

In laying out the essentials for the study of technology, *STL* represents a recommendation from educators, engineers, scientists, mathematicians, and parents about what skills and knowledge are needed in order to become technologically literate. It is not, however, a federal policy or



mandate. Nor does *STL* prescribe an assessment process for determining how well students are meeting the standards, although it does provide criteria for this assessment.

### *Format of STL*

The individual standards presented in *STL* are organized into five major categories:

- The Nature of Technology (Chapter 3)
- Technology and Society (Chapter 4)
- Design (Chapter 5)
- Abilities for a Technological World (Chapter 6)
- The Designed World (Chapter 7)

Under the five major categories, there are 20 standards. See Figure 1 for a listing of the categories and standards.

### **Figure 1. Listing of Standards for Technological Literacy**

Taken from International Technology Education Association. (2000). *Standards for technological literacy: Content for the study of technology*. Reston, VA: Author.

#### **The Nature of Technology**

- Standard 1. Students will develop an understanding of the characteristics and scope of technology.
- Standard 2. Students will develop an understanding of the core concepts of technology.
- Standard 3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

#### **Technology and Society**

- Standard 4. Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5. Students will develop an understanding of the effects of technology on the environment.
- Standard 6. Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7. Students will develop an understanding of the influence of technology on history.

#### **Design**

- Standard 8. Students will develop an understanding of the attributes of design.
- Standard 9. Students will develop an understanding of engineering design.
- Standard 10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

#### **Abilities for a Technological World**

- Standard 11. Students will develop the abilities to apply the design process.
- Standard 12. Students will develop the abilities to use and maintain technological products and systems.
- Standard 13. Students will develop the abilities to assess the impact of products and systems.

#### **The Designed World**

- Standard 14. Students will develop an understanding of and be able to select and use medical technologies.
- Standard 15. Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.
- Standard 16. Students will develop an understanding of and be able to select and use energy and power technologies.
- Standard 17. Students will develop an understanding of and be able to select and use information and communication technologies.

- Standard 18. Students will develop an understanding of and be able to select and use transportation technologies.
- Standard 19. Students will develop an understanding of and be able to select and use manufacturing technologies.
- Standard 20. Students will develop an understanding of and be able to select and use construction technologies.

*Standards*

*Standards for Technological Literacy: Content for the Study of Technology (STL)* has written statements about what is valued in the study of technology that can be used for judging quality. The document specifies what every student should know and be able to do in order to be technologically literate and offers criteria to judge progress toward a vision of technological literacy for all students. *STL* contains requirements for students to become technologically literate as a result of their education from kindergarten through Grade 12. These standards set forth goals to be met in five major categories of technology. (See Figure 1.)

*Benchmarks in STL*

Benchmarks play a vital role in *STL*. They provide the necessary elaboration of the broadly stated standards. Benchmarks, which are statements that enable students to meet a given standard, are provided for each of the 20 standards at the K-2, 3-5, 6-8, and 9-12 grade levels. (See Figure 2 for a sample of the benchmarks.) The benchmarks are followed by supporting sentences that provide further detail, clarity, and examples. Like the standards, the benchmarks are required for students to meet the standards. Teachers should feel free to add to the benchmarks to further enhance the ability of the student to meet a given standard.

**Figure 2. A Representative Standard and Benchmarks**

Standard 8 – Students will develop an understanding of the attributes of design.

*In order to realize the attributes of design, students in grades 3-5 should learn that*

- C. The design process is a purposeful method of planning practical solutions to problems.** The design process helps convert ideas into products and systems. The process is intuitive and includes such things as creating ideas, putting the ideas on paper, using words and sketches, building models of the design, testing out the design, and evaluating the solution.
- D. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.** Technological designs typically have to meet requirements to be successful. These requirements usually relate to the purpose or function of the product or system. Other requirements, such as size and cost, describe the limits of a design.

From research in education, it has been found that if previously learned knowledge is tapped and built upon, it is likely that children will acquire a more coherent and thorough understanding of these processes than if they are taught them as isolated abstractions (NRC, 1999). With this in

mind, the benchmarks are articulated or “ramped” from Grades K-12 to progress from very basic ideas at the early elementary school level to the more complex and comprehensive ideas at the high school level. Certain content “concepts,” such as systems, resources, requirements, optimization, and trade-offs, processes, and controls, are found in the benchmarks, which extend across various levels to ensure continual learning of an important topic related to a standard.

### ***Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards***

In March 2003, the International Technology Education Association (ITEA) released *Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards (AETL)* at its 65<sup>th</sup> annual conference in Nashville, Tennessee. *AETL* is based on *Standards for Technological Literacy: Content for the Study of Technology (STL)* and is designed as a companion to *STL*. *AETL* was developed by TfAAP from 2000 to 2003.



The three sets of standards in *AETL* support *STL*. *AETL* provides standards and guidelines that address student assessment, professional development, and program enhancement. The primary goal of all the standards is to help students achieve technological literacy. The eleven-person TfAAP Advisory Group provided valuable counsel in the best practice of standards development to the project. They met annually in Washington, DC.

The TfAAP Standards Writing Team was made up of 27 people (three teams of nine). They provided detailed input in fashioning the initial draft of *AETL*, and their continued review and input have added strength and quality to the final document. The development and refinement of *AETL* took place over three years (2000-2003) and involved hundreds of educators and experts in the fields of technology, mathematics, science, engineering, and other disciplines. Their input was attained through various methods, including hearings, Web-based electronic document review, and individual reviews through the mail and in person. Three formal drafts of *AETL* were developed and reviewed before the final draft was prepared in autumn 2002.

#### *Overview of AETL*

Chapters 1 and 2 of *AETL* provide valuable introductory material. Chapter 1 is an overview that presents the rationale of need and conceptually introduces Chapters 3, 4, and 5. Chapter 2 discusses relevant principles and definitions.

*AETL* consists of three separate but interrelated sets of standards.

- Student Assessment Standards (Chapter 3)
- Professional Development Standards (Chapter 4)
- Program Standards (Chapter 5)

The standards in *AETL* are based upon *STL*. To fully and effectively implement the content standards in *STL*, all of the *AETL* standards presented in Chapters 3, 4, and 5 must be met through the guidelines. While *AETL* is designed to leave specific curricular decisions to educators, teachers, professional development providers, and administrators should use *STL* and

*AETL* as guides for advancing technological literacy for all students. And finally, Chapter 6 of *AETL* invites users to participate in the visionary basis of *STL* and *AETL*.

### *Student Assessment Standards (Chapter 3)*

The definition for student assessment presented in *AETL* is “the systematic, multi-step process of collecting evidence on student learning, understanding, and abilities and using that information to inform instruction and provide feedback to the learner, thereby enhancing student learning.” The primary audience for the student assessment standards is teachers. It is important to note that the standards are applicable to those who educate students on any aspect of technology.

The five organizational topics for the student assessment standards are:

- Consistency with *STL*
- Intended Purpose
- Research-Based Assessment Principles
- Practical Contexts
- Data Collection

While the student assessment standards (see Figure 3) define how assessment of technological literacy should be designed and implemented, Chapter 3 does not provide a test, quiz, or other handy instrument to be photocopied and used in the laboratory-classroom. This task is left—as it should be—to individual teachers and others.

<b>Figure 3. Student Assessment Standards</b>	
A-1.	Assessment of student learning will be consistent with <i>Standards for Technological Literacy: Content for the Study of Technology (STL)</i> .
A-2.	Assessment of student learning will be explicitly matched to the intended purpose.
A-3.	Assessment of student learning will be systematic and derived from research-based assessment principles.
A-4.	Assessment of student learning will reflect practical contexts consistent with the nature of technology.
A-5.	Assessment of student learning will incorporate data collection for accountability, professional development, and program enhancement.

Users of the student assessment standards should recognize that student assessment should be *formative* (ongoing) as well as *summative* (occurring at the end). Further, users should recognize that the assessment process should be *informative*, that is, it should inform students and teachers about progress toward technological literacy and provide data on the effectiveness of instruction and the program. Teachers should use student assessment data to improve classroom practices,

plan curricula, develop self-directed learners, report student progress, and research teaching practices.

#### *Professional Development Standards (Chapter 4)*

Chapter 4 presents criteria for professional development providers (including teacher educators, supervisors, and administrators) to use in planning professional development. Professional development includes a continuous process of lifelong learning and growth that begins early in life, continues through the undergraduate, pre-service experience, and extends through the in-service years.

The standards are applicable to those who prepare teachers on any aspect of technology, including teachers whose primary focus may be another subject area.

The seven organizational topics for the professional development standards are:

- Consistency with *STL*
- Students as Learners
- Curricula and Programs
- Instructional Strategies
- Learning Environments
- Continued Professional Growth
- Pre-Service and In-Service

See Figure 4 for a listing of the professional development standards.

Users of this document should focus on preparing teachers to continue to pursue professional development to keep up with changing technologies and current research on how students learn. The necessity to address issues of technological literacy is pertinent to all programs that prepare teachers of every grade level, including K-5 elementary teachers and teachers of science, mathematics, social studies, language arts, and other content areas. Therefore, faculty members in every teacher preparation program can use *STL* and *AETL* to determine how the technological literacy of teacher candidates can be enhanced.

#### **Figure 4. Professional Development Standards**

- PD-1. Professional development will provide teachers with knowledge, abilities, and understanding consistent with *Standards for Technological Literacy: Content for the Study of Technology (STL)*.
- PD-2. Professional development will provide teachers with educational perspectives on students as learners of technology.
- PD-3. Professional development will prepare teachers to design and evaluate technology curricula and programs.
- PD-4. Professional development will prepare teachers to use instructional strategies and enhance technology teaching, student learning, and student assessment.
- PD-5. Professional development will prepare teachers to design and manage learning environments that promote technological literacy.
- PD-6. Professional development will prepare teachers to be responsible for their own continued professional growth.
- PD-7. Professional development providers will plan, implement, and evaluate the pre-service and in-service education of teachers.

#### *Program Standards (Chapter 5)*

As defined in *AETL*, the program refers to everything that affects student learning, including content, professional development, curricula, instruction, student assessment, and the learning environment implemented across grade levels. The system-wide technology program manages the study of technology in technology laboratory-classrooms as well as in other content area classrooms. The primary audience for the program standards are twofold: (1) teachers and (2) administrators (including supervisors). As a result of this, the guidelines are divided for addressing these two audiences.

Chapter 5 presents criteria for teachers and administrators (including supervisors) responsible for the technology program and system-wide technology program. The standards are applicable to those who organize the learning of students on any aspect of technology. The five organizational topics for the program standards are:

- Consistency with *STL*
- Implementation
- Evaluation
- Learning Environments
- Management

Users of the program standards should recognize that thoughtful design and implementation of technology programs at school levels and of system-wide technology programs at district levels are necessary to provide comprehensive and coordinated experiences for all students across grade levels and disciplines, including science, mathematics, social studies, language arts, and other content areas. The program standards (see Figure 5) call for extending technology programs beyond the domain of the school. Technology programs should, for example, involve parents, the community, business and industry, school-to-work programs, and higher education as well as professionals in engineering and other careers related to technology. And finally, it is essential that adequate support for professional development be provided by administrators to ensure that teachers remain current with the evolving fields of technology and educational research.

**Figure 5. Program Standards**

- P-1. Technology program development will be consistent with *Standards for Technological Literacy: Content for the Study of Technology (STL)*.
- P-2. Technology program implementation will facilitate technological literacy for all students.
- P-3. Technology program evaluation will ensure and facilitate technological literacy for all students.
- P-4. Technology program learning environments will facilitate technological literacy for all students.
- P-5. Technology program management will be provided by designated personnel at the school, school district, and state/provincial/regional levels.

*Guidelines, Enablers to Meet the Standards*

Guidelines play a vital role in *AETL*. Under each standard a number of guidelines are presented and must be addressed to enable the user to meet a given standard. ITEA does not recommend that users eliminate any of the guidelines; however, users may add to the guidelines if there is a need to accommodate local differences. A sample standard (A-4) with related guidelines is presented in Figure 6.

**Figure 6. Standard A-4 with Related Guidelines**

***Standard A-4: Assessment of student learning will reflect practical contexts consistent with the nature of technology.***

**Guidelines for meeting Standard A-4 require that teachers consistently:**

- A. Incorporate technological problem solving.
- B. Include variety in technological content and performance-based methods.
- C. Facilitate critical thinking and decision making.
- D. Accommodate for modification to student assessment.
- E. Utilize authentic assessment.

## New Technology Standards-Based Addenda

Educational standards provide criteria for learning and ensure quality in educational programs. Standards-based technology programs can deliver technological literacy. ITEA offers two published standards documents for technological literacy: *Standards for Technological Literacy: Content for the Study of Technology (STL)* (ITEA, 2000/2002) and *Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards (AETL)* (ITEA, 2003). The purpose of these documents is to advance the technological literacy of all students. Together, they identify a vision for developing a technologically literate citizenry.

The ITEA Addenda series (to *STL* and *AETL*) is part of the standards package for technological literacy. They were produced by the TfAAP staff with special assistance from ITEA's Center to Advance the Teaching of Technology and Science (CATTS). These addenda are based on the standards but include concrete processes or suggestions for incorporating national, state, and/or local technological literacy standards into the programs of all students throughout Grades K–12. Additionally, all of the documents contain worksheets for educators to use to make changes specific to their locality and situation. The new addenda series marks another pioneering effort in educational reform, as it provides a supplement to educational standards that focuses on the entire picture of program reformation rather than concentrating solely on curricula. The new addenda are:

- **Student Assessment**



*Measuring Progress: A Guide to Assessing Students for Technological Literacy* (ITEA, 2004)

- **Programs**



*Realizing Excellence: Structuring Technology Programs* (ITEA, 2005)

- **Curricula**



*Planning Learning: Developing Technology Curricula* (ITEA, 2005)

- **Professional Development**



*Developing Professionals: Preparing Technology Teachers* (ITEA, 2005)

## **Other Research**

The International Technology Education Association's (ITEA) Technology for All Americans Project (TfAAP) has been the longest and most comprehensive research effort in the history of the profession. In addition to the years of developmental research guided by ITEA's TfAAP in developing, reviewing, validating, and finalizing *R&S*, *STL*, and *AETL*, the project has been involved in other formal research on people's knowledge of and beliefs about technology.

In 2001, ITEA commissioned the Gallup Organization from Princeton, New Jersey to conduct a nationwide survey of 1,000 homes to assess what Americans know about technology. This research was funded by NSF and NASA. Three years later, in 2004, ITEA's TfAAP revisited this effort and hired the Gallup Organization to conduct a second poll. In the second research effort, five questions from the original poll were carried over to the 2004 instrument and eleven new questions were generated by a committee to complete the instrument. A report of both the 2001 and 2004 ITEA/Gallup polls can be found at the ITEA's website ([www.iteawww.org](http://www.iteawww.org)).

Also in 2001, TfAAP staff conducted a status survey of state supervisors of technology education on what was happening in their state. Again, this state supervisor status survey research was repeated in 2004. Articles on the findings of both status surveys can be found at ITEA's website ([www.iteawww.org](http://www.iteawww.org)).

Jill Russell, the Third Party Evaluator for TfAAP, has conducted surveys at numerous ITEA Conferences on the implementation progress of *STL* and *AETL*. Additionally, she has conducted a survey of all teacher education institutions in the U.S. that prepare pre-service teachers to teach technology. This teacher education survey investigated the level of use of *STL* and *AETL* in the preparation of new teachers. These research results are provided in previous articles by Dr. Russell in *The Technology Teacher* and *The Journal of Technology Education*.

## **Implementation of *STL* and *AETL***

The ITEA's TfAAP staff has conducted numerous workshops, hearings, presentations, and program development activities around the country since 1994. In the summer of 2000, the TfAAP staff conducted workshops at 11 NASA centers around the U.S. There were approximately 250 participants from 38 states who received an orientation to *STL*.

In the early fall of 2000, a group of six Standards Specialists nationwide were formed to help implement *STL* and *AETL*. They have conducted over 70 workshops and presentations in the U.S., Thailand, and Canada on *STL* and *AETL*. These Standards Specialists will continue to offer implementation assistance after the TfAAP project finishes.

The TfAAP staff has undertaken many public relations efforts to inform others about *STL* and *AETL*. Numerous articles in technology education periodicals and journals have been written. A new website to inform the public about the importance of technological literacy has been created by TfAAP. It is [www.iteawww.org/ACT/](http://www.iteawww.org/ACT/). Suggestions and input to the ACT website are welcome; please send correspondence to ITEA ([www.iteawww.org](http://www.iteawww.org)). Sessions at the ITEA Conference have been conducted on how to develop an effective public relations program.

## **Challenges for the Future**

ITEA's TfAAP and its work to generate *STL*, *AETL*, and other related materials does not represent an end, but a beginning. We would like to thank all of the hundreds of people who have contributed to and gave input to us. In other fields of study, developing standards has often proven to be the easiest step in a long, arduous process. Therefore, getting these technology standards accepted and implemented in Grades K-12 in every school will be far more difficult and daunting than developing them has been. Only through the combined efforts of educational decision makers everywhere will we be able to ensure that all students develop higher levels of technological literacy.

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