Articles

Evidence Related to Awareness, Adoption, and Implementation of the Standards for Technological Literacy: Content for the Study of Technology

Jill F. Russell

Over the past twenty years American education has seen many changes, and most notable have been those related to accountability and assessment. One aspect of these changes has been the movement toward more specified student learning outcomes. In discipline after discipline content standards have been developed outlining that which students should achieve as a result of their schooling. The field of technology education has been no exception. Early in the game, in the 1980's, standards for technology education programs (although not for student achievement, per se) were developed. Then in the fall of 1994, the International Technology Education Association (ITEA) initiated the Technology for All Americans Project. This project received grant support from both the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA).

To this point the Technology for All Americans Project has included three phases. Cumulatively the following have been developed: (1) a rationale and structure for technology education (ITEA, 1996); (2) content standards elaborating what K-12 students should know and be able to do with respect to technology (ITEA, 2000); and (3) standards for technology education programs, professional development, and assessment of student achievement (ITEA, 2003). As such, these efforts over the past decade have constituted an important movement for the promotion of technological literacy both within technology education and in related circles.

Although the development of the various standards has been an important task, implementation becomes the critical next step if the standards are to ever reach fruition. The most well-conceived, quality-crafted standards do little good if they sit on the shelf unused. The purpose of this paper is to examine the evidence related to awareness, adoption, and implementation of ITEA's *Standards for Technological Literacy: Content for the Study of Technology* (ITEA, 2000). The standards will be referred to here as *STL*. The information presented is in part related to the data generated through the external evaluation of the Technology for All Americans Project. Methodology will be described briefly and findings reviewed. Conclusions as to progress will then be presented.

Background

A concern regarding the achievement of technological literacy for all Americans is that although technology education has been taught in schools for years, it has often been delivered as a single short course. In that context, there is limited opportunity for significantly influencing the technological literacy of the general public. Yet as the years have passed, technology has advanced at an exponential rate such that it now has a huge impact on life for almost every American. As a result, the citizens of the United States are somewhat handicapped by this heavy reliance upon, but lack of knowledge about, technology. Simultaneously, Trends in International Mathematics and Science Study (TIMSS) testing has revealed math and science achievement among youth in America does not compare well internationally. All of this contributes to a potentially weakened scenario in relation to maintaining the Nation's quality of life, defense, and productivity (National Academy of Sciences, 2002).

In an effort to assess, at a broad level, the American public's views about technology education, the International Technology Education Association sponsored a Gallup Poll on the topic of technological literacy (Rose and Dugger, 2002). A follow up poll was conducted in 2004 (Rose, Gallup, Dugger, and Starkweather). The results of these polls further document the importance of technological literacy. In both national samplings, three-quarters of all respondents indicated they felt it was very important "for people at all levels to develop some ability to understand and use technology." And in general, the respondents felt the study of technology should be included in the school curriculum.

Of course technology educators would agree, and many would argue further that technology education should be delivered within the context of a K-12 articulated model – whether it is taught solely by technology educators, or infused throughout the curriculum and taught by educators in many disciplines. The technological literacy standards movement has helped to create awareness of the need and prompted discussion of the issues. But large-scale implementation will be required to actually move forward in achieving technological literacy by the American populace.

Methods

This article will present data and information collected by this author, and others (see section entitled Related Evidence) regarding awareness, adoption, and implementation of the *STL*. In terms of this author's work, data collection has included both surveys and interviews/observation. At each of the ITEA annual conferences of 2003, 2004, and 2005 a survey of participants regarding their awareness of, and views about, the standards for technological literacy, was conducted. This target group included technology education teachers, elementary teachers, teacher educators, technology education supervisors, and others. In addition, a survey of technology education teacher preparation institutions was conducted specific to the topic of teacher preparation. The data generated from those surveys will be presented herein. A visit to the Boston Museum of Science included observations and an interview with the Senior Vice President for Research, Production, and Development, who provided further information.

Findings

The findings will be presented in accordance with each specific data collection initiative.

Surveys at the ITEA Annual Conference

A short survey about awareness of ITEA's standards for technological literacy was included in the registration packet for all attendees of the ITEA Annual Conference in Nashville (spring 2003) and in Albuquerque (spring 2004). The survey included a brief request for input from the Executive Director of ITEA, and the promise of inclusion in a prize drawing if the survey was completed and submitted. Two hundred and sixty-three of the 1195 conference registrants in 2003 completed and returned the survey (22% of those present at the conference), as did 125 of the total (1042) conference registrants at the 2004 conference (constituting a 12% rate of participation).

Table 1 shares the respondents' familiarity with and views about the *Standards for Technological Literacy.* Familiarity with the *STL* has grown from 57% to 86% from 2003 to 2004 for ITEA conference attendees responding to the survey. The ratings of quality have increased over that time period as well. Although positive initially, with just over one-third rating the *STL* as excellent in 2003, almost half rated the *STL* as excellent in 2004. Likewise, the expectations for *STL* to have a significant impact on technology education and K-12 education in general, both increased from 2003 to 2004 (69% expecting a significant impact on technology education, and 51% expecting a significant impact on K-12 education in general – both in 2004). Opinion was almost unanimous both years as to the perceived importance of *STL*.

As a follow up to item 5 (in Table 1) above, when asked why they felt the standards were important, the respondents provided a range of opinions, including the following representative reasons. They reported that the *STL*: provide credibility, viability, validity, and accountability; serve as a guide; offer goals; enable political momentum; provide a means for communicating with the public; give continuity and standardization for teaching; reflect and explain the best thinking of technology educators; and respond to the fact that technology is integral to life in America today.

Clearly these respondents value the technology education standards, understand and can articulate their importance, and expect the standards to impact both the field of technology education as well as K-12 education generally. As such, a conclusion that some portion of these people may make efforts to incorporate *STL* in their teaching, is likely warranted.

A similar survey was made available at the 2005 ITEA conference (highly visible, at registration area). The survey promised entry into a prize drawing for an Ipod Player. Ninety-six individuals completed and returned the survey of the 1548 conference attendees, constituting a 6.2% response rate. The 2005 survey questions varied somewhat. Those results are presented in Table 2.

Table 1: Survey Results – 2003 and 2004 Conference Respondents' Familiarity With and Views About the *STL*

Question	2003 N	2003 %	2004 N	2004 %
1) Are you familiar with the ITEA's *Standards for Technological Literacy*?				
Yes	151	57.4%	107	85.6%
Somewhat	97	36.9%	12	9.6%
No	15	5.7%	6	4.8%
2) How would you rate the quality of the *Standards for Technological Literacy*? (*Note:* "Good" was not offered as a response option in 2004)				
Excellent	90	34.2%	60	48.0%
Very Good	105	40.0%	51	40.8%
Good	42	15.9%	0	0 %
Fair	7	2.7%	6	4.8%
Poor	0	0%	1	0.8%
Don't Know	19	7.2%	6	4.8%
No Response	0	0%	1	0.8%
3) What impact would you expect the *Standards for Technological Literacy* to have on Technology Education?				
Significant Impact	162	61.6%	86	68.8%
Some Impact	91	34.6%	38	30.4%
Very Little Impact	3	1.1%	0	0%
No Impact	0	0%	0	0%
Don't Know	7	2.7%	0	0%
No Response	0	0%	1	0.8%
4) What impact would you expect the *Standards for Technological Literacy* to have on K-12 education?				
Significant Impact	117	44.5%	64	51.2%
Some Impact	126	47.9%	51	40.8%
Very Little Impact	9	3.4%	7	5.6%
No Impact	3	1.1%	0	0%
Don't Know	8	3.0%	0	0%
No Response	0	0%	3	2.4%
5) Do you think the *Standards for Technological Literacy* are important? Why?				
Yes	258	98.1%	122	97.6%
No	2	0.7%	1	0.8%
Don't Know	3	1.1%	0	0%
No Response	0	0%	2	1.6%

Table 2: 2005 ITEA Conference Survey Results

Question	N	%
1) Do you believe the *Standards for Technological Literacy: Content for the Study of Technology* (2000) are having a positive impact upon technology education?		
Great Impact	43	44.8%
Some Impact	41	42.7 %
Limited Impact	12	12.5%
2) Do you believe the *Standards for Technological Literacy* have the potential long-term to improve technological literacy among K-12 students?		
Greatly	73	76.0%
Somewhat	22	22.9%
Very Little	1	1.0%
3) Please provide your opinion as to the quality of the *Standards for Technological Literacy*:		
Excellent	38	39.6%
Very Good	48	50.0%
Fair	9	9.4%
Poor	0	0%
No Response	1	1.0%
4) Are you familiar with *Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards* (2003), also known as *AETL*?		
Very Familiar	27	28.1%
Somewhat Familiar	54	56.3%
Not Familiar	15	15.6%
5) If you answered above that you were 'very' or 'somewhat' familiar with *AETL*, do you think these standards will assist you in preparing for standards-based student assessment, professional development, and programs in technology education?		
Yes	63	65.6%
Not Sure	19	19.8%
No	0	0%
No Response	14	14.6%

The 2005 results were very positive. Most respondents believe the content standards (*STL*) are having a positive impact and have the potential for long-term benefits for K-12 students' technological literacy. Almost ninety percent (89.6% of the 96 respondents) feel the *STL* quality is either excellent or very good. Eighty-four percent say they are somewhat or very familiar with the *AETL*, and approximately two-thirds feel the *AETL* will be useful in assisting them in preparing for standards-based student assessment, professional development, and programs.

Survey of Teacher Preparation Programs

In the spring of 2003 a survey was conducted of teacher preparation organizations. The mailing list was based upon the ITEA's institutional membership category. Fifty-one out of the total list of fifty-nine institutional members represented teacher preparation organizations in the United States. The invitation to participate in the survey was extended by the Executive Director of ITEA to those fifty-one organizations. The primary purpose of the survey was to ascertain the extent to which the teacher preparation organizations were making changes in their programs to reflect the *Standards for Technological Literacy*. Fifteen responses were received, constituting a 29% response rate. Fourteen of the fifteen respondents (93.3%) reported accreditation by the National Council for Accreditation of Teacher Education (NCATE).

Although the data will be presented in the aggregate, the fifteen responding institutions are named here to demonstrate their representativeness: Appalachian State University, Ball State University, Illinois State University, Indiana State University, Mankato State University, Millersville University, North Carolina State University, Ohio State University, Old Dominion University, St. Cloud State University, Southern Utah University, University of Idaho, University of Maryland Eastern Shore, Utah State University, and Valley City State University.

Table 3 describes the participating teacher preparation programs in terms of size. The average number of students enrolled by these institutions was fifty-two students, with an average of eleven expected to graduate that year.

Table 4 presents information on the extent to which these programs have addressed *STL*. It is evident these respondents have gone to great lengths to address *STL* in their programs. Almost all of the respondents indicated they agree that: their program explicitly addresses *STL*, students are required to have a copy of the *STL*, students are required to prepare *STL*-based lesson plans, graduates use *STL* in their teaching, and their faculty are familiar with *STL* and participate in outside-the-department work related to *STL*. The majority of the respondents offer a course specific to *STL*.

Table 5 describes how these teacher preparation programs assure graduates' knowledge and competency with respect to the *STL*. These programs indicated the students study and practice with the *STL* through various courses and field-work experiences, that program changes have been introduced specific to the *STL*, that there are *STL* benchmarks incorporated within the program, and that posters and portfolios reflect the *STL*.

These respondents have updated their programs, student assignments, and expectations to align with *STL*. This has been accomplished in a myriad of ways that could be helpful to others at the point of beginning the alignment process.

Although only 15 responses were received to this survey, these respondents are all very involved with *STL* and the professional development standards. This is likely influenced by the

Table 3: Program Demographics

Question	Range	Mean	Median	Standard Deviation
1) How many technology education undergraduate majors are enrolled in your program?				
	15-200	52.4	40	42.94
2) How many graduates in technology education do you expect for 2002-2003?				
	2-45	11.4	8.5	10.27

Table 4: The Extent to Which the Programs Have Addressed the *STL*

To what extent do the following statements characterize your technology education teacher preparation program?

Statement	N	%
1) The *Standards for Technological Literacy: Content for the Study of Technology (STL)* are addressed explicitly within our program.		
Strongly Agree	10	66.7%
Agree	5	33.3%
Disagree	0	0%
Strongly Disagree	0	0%
2) Our teacher preparation students are required to have a copy of the *STL* for their coursework.		
Strongly Agree	8	53.3%
Agree	6	40.0%
Disagree	1	6.7%
Strongly Disagree	0	0%
3) Our teacher preparation students are required to prepare a lesson plan this is *STL*-based.		
Strongly Agree	8	53.3 %
Agree	7	46.7%
Disagree	0	0%
Strongly Disagree	0	0%
4) Our faculty are very familiar with the *STL*.		
Strongly Agree	9	60.0%
Agree	6	40.0%
Disagree	0	0%
Strongly Disagree	0	0%
5) We have a course that concentrates primarily on the *STL*.		
Strongly Agree	4	26.7%
Agree	5	33.3%
Disagree	6	40.0%
Strongly Disagree	0	0%
6) Our faculty work with state department or local technology education supervisors or teachers in k-12 schools to support implementation of the *STL*.		
Strongly Agree	7	46.7%
Agree	7	46.7%
Disagree	1	6.7%
Strongly Disagree	0	0%

Statement	N	%
7) Our faculty present on the *STL* outside of department course offerings (e.g. at in-services for a school/district, or at state/regional conferences).		
Strongly Agree	6	40.0%
Agree	6	40.0%
Disagree	3	20.0%
Strongly Disagree	0	0%
8) Our TECA student group has engaged in *STL*-based activities (the statistics for item 8 represent the 12 out of 15 respondents with a TECA organization):		
Strongly Agree	4	33.3%
Agree	7	58.3%
Disagree	1	8.3%
Strongly Disagree	0	0%
9) We would find a user's guide for the *STL* very helpful.		
Strongly Agree	4	26.6%
Agree	8	53.3%
Disagree	26	13.3%
Strongly Disagree	0	0%
No Response	1	6.6%
10) Our graduates make use of the *STL* as the foundation for their teaching.		
Strongly Agree	4	26.7%
Agree	10	66.7%
Disagree	1	6.7%
Strongly Disagree	0	0%
11) Our faculty have identified and implemented expected outcomes specific to the *STL* for teacher preparation students.		
Strongly Agree	5	33.3%
Agree	9	60.0%
Disagree	1	6.7%
Strongly Disagree	0	0%

Table 5: Means of Assuring Graduates' Knowledge and Competency
Examples Provided

1) Students study, evaluate and practice *STL* through all methods, subject areas, and educational coursework
2) Revisions were made to the undergraduate program – changing and/or designing new courses
3) Benchmarks are included in all courses
4) Students are required to prepare lesson plans that include an assessment of those standards being addressed
5) *STL* are addressed through field based and student teaching experiences
6) A poster of the *STL* and state content standards is posted in all classrooms
7) Students are required to complete a portfolio that relates to the standards. They also present a standard in class
8) *STL* are integrated with learning outcomes

Note: Original question was stated as follows – How does your program assure graduates' knowledge and competency with respect to the Standards for Technological Literacy?

fact that 14 of the 15 respondents indicate they have NCATE accreditation, and that NCATE-approved institutions are already in the mode of curricular alignment with various important criteria, such as the *STL*. In addition, the NCATE criteria for technology education programs were developed based on ITEA input. In that sense, it may have been easier for these programs to respond to the questions posed in the survey because they had already taken these steps.

Boston Museum of Science Activity

Another indicator of the impact of the *STL* is evidenced by the activity underway at the Boston Museum of Science. Following are the conclusions from a visit to the Boston Museum of Science where the Senior Vice President for Research, Production, and Development was interviewed (L. Bell, personal communication, March 6, 2004), and a personal tour was offered to the author.

The Boston Museum of Science has been moving from an almost exclusive science focus to a broader science and technology emphasis over the past several years. The museum hopes to serve as a "lighthouse" organization in leading the way within the museum world to technological literacy. They have used the *STL* as an organizing mechanism in their work.

The activities in which they have engaged are ambitious. They include the following (Boston Museum of Science web-site (2005)):

A Star Wars Exhibit is being developed (with help from Lucasfilm Ltd.) which will implicitly address a number of *STL* standards and benchmarks. This exhibit will be constructivist in its approach. It will open first in Boston and will subsequently become a traveling exhibit across the country. Web resources will be available for teachers to use before and after a visit to the exhibit classes.

The museum has established the National Center for Technological Literacy. Its purpose is to: create educational products that promote technological literacy, conduct research about teaching and learning related to technological literacy, and reach out to other organizations to share useful information regarding technological literacy. The Center has multiple means through which it works: (1) advocacy and standard development, (2) curricular materials, (3) an educational resource center, and (4) professional development.

Funding has been awarded to the Museum to develop middle level and high school technology/engineering courses. Teachers are being used in the development process.

The Boston Museum of Science has been "high-profile" in its adoption of the *STL*. The staff have reported on their activities to museum professionals, school professionals, and presented to national audiences. In addition, they have published accounts of their work and progress.

Related Research

Related research has been conducted on awareness, adoption, and implementation of the standards.

In October 2002 Phillip Cardon reported on the "Acceptance of National Standards for Technological Literacy by Technology Teacher Educators" at the Mississippi Valley Technology Teacher Education Conference (Cardon, 2002). Cardon had surveyed 102 institutions offering technology education programs, and received a 51% response rate. His research questions focused on the extent to which the *STL* would provide direction and drive reforms in technology teacher education, and whether or not teacher educators were ready to adopt the new standards.

The survey results shared indicated that at that time almost 30% of the programs had already implemented the *STL* and another 62% were in the process of doing so. The reasons cited for implementing the *STL* included: for program improvement, to address a state mandate to use the standards, to be more competitive, and because the standards were perceived as being "the guiding force" and the "most current approach."

A survey conducted by Daugherty of individual faculty in technology education teacher preparation programs was sent in the fall of 2003 to 123 faculty listed in the *Industrial Teacher Education Directory* (Bell, 2002). A 55% response rate was achieved. The survey was designed to assess: (1) the degree to which technology teacher educators support the *STL* and the corollary professional development standards from *Advancing Excellence in Technological Literacy* (ITEA, 2003), and (2) the extent to which substantial curricular and pedagogical change is viewed as being needed.

Daugherty (2003) found much support for the standards being taught in teacher preparation programs. When the standards were stated, and respondents were asked to rate the agreement with technology teacher education programs preparing individuals to teach those items, all items except two (out of 22) received a mean rating between 4 (agree) and 5 (strongly agree). The highest rated items were: "core concepts of technology," "attributes of the design process," "role of experimentation in problem-solving," and "effects of technology on the environment." The two lowest rated items, receiving a rating between 3 (undecided) and 4 (agree), were "core concepts of medical technologies," and "core concepts of agriculture and biotechnologies." In terms of the perceived need for change, over 62% of the respondents indicated that "major change was called for in the field." Many of those indicating major change was not needed, felt that such change had already occurred.

Survey on the Status of Technology Education in the U.S.

In the spring and summer of 2004 the Technology for All Americans Project staff conducted a survey of the states as to the status of technology education, including use of the *STL*. They contacted the state technology supervisor or their alternates to collect their data. Following are the results regarding *STL* usage (Meade and Dugger, 2004): Forty of the fifty states (80%) reported that the *STL* is used at the state, district, or local level within their state; 14% said that it is not used; four percent said they did not know; and two percent did not respond to the item. In addition, Meade and Dugger reported that more than half of the states indicated they "have either based their own standards and curricular materials on the *STL* or aligned their standards and curricular frameworks with the *STL*."

West Ed/Edward (Ted) Britton Research

A new publication, *Bringing Technology Education into K-8 Classrooms: A Guide to Curricular Resources About the Designed World* (Britton et. al, 2005), shares the results of an NSF-funded project that conducted a comprehensive and rigorous review of curricular materials published since the year 2000. The review specifically examined the extent to which the *STL* were incorporated into major technology textbooks and other curriculum resources. The primary intent of the project was to help teachers in the selection process, but it also provides input as to the influence of the *STL*.

Findings indicate that although there is variation among the new textbooks released

since the publication of the *STL*, the books generally do address the standards and benchmarks. Britton notes that some books address certain areas better than others, and that ideally a teacher would have access to several textbooks, so that he/she could make use of the best information and activities from each.

Doctoral Dissertation in Florida

A doctoral dissertation entitled "District-level Predictors of Implementation of the Standards for Technological Literacy in Florida" reported that the extent to which *STL* had been implemented in 60 school districts in Florida was related primarily, among a number of variables, to district enrollment (Loveland, 2003). That is, larger districts were more likely to have adopted *STL*.

Sales of STL

At the point of preparation of this document, almost 15,000 copies of the *STL* have been sold (August, 2005). This figure is above and beyond the distribution of copies as a part of the Technology for All Americans Project dissemination efforts. Although purchase of the *STL* does not guarantee adoption or implementation, it is a prerequisite step.

Standards Specialists

As a part of the Technology for All Americans Project, six technology educators were identified as standards specialists who would be available to districts, states, and professional organizations to provide presentations and workshops on the *STL*. This offering has been in place several years now, and over that time period approximately 85 presentations/ workshops have been delivered to almost 3,500 participants. The standards specialists have also authored various articles and supplementary materials in support of the *STL*.

Translation to Other Languages

Since the 2000 publication date, the *STL* has been translated and published in Chinese, German, Finnish, and Japanese (for further information on the international translations, contact William Dugger, Jr. via email: wdugger@iteaconnect.org). It is serving both an international and national role in promoting the use of standards for technological literacy.

Supplementary Materials

Through ITEA's Center to Advance the Teaching of Technology and Science (CATTS) multiple documents have been prepared which serve as supplements to the *STL*. These include curricular materials for various grade levels and specific courses, program guides, and resources to help implement the standards. In addition, there are numerous curriculum development and assessment efforts underway at institutions across the country with funding from such sources as the National Academy of Engineering and the National Science Foundation.

Conclusions

Cumulatively, the data from these various sources support the conclusion there has been extensive activity related to the promotion of awareness, adoption, and implementation of the *STL* since its publication in 2000. Broad awareness of the *STL* among technology educators is fairly certain. Many value the *STL* and believe in its importance; they have purchased materials and participated in professional development. Adoption is claimed in a number of cases in that many states, districts, and teacher preparation institutions have made the choice to align with the *STL*. *STL* is being incorporated in textbooks and curricular materials. Organizations outside the traditional K-16 world have chosen to align their efforts with the *STL*. Internationally there is evidence of interest in the standards. Researchers are looking at the use of the *STL* in teacher preparation, in textbooks, and in school districts. True implementation is an activity that happens primarily behind closed classroom doors, and hence can be less amenable to measurement. But progress in the desired direction is underway.

Any single piece of evidence that has been presented here would likely be insufficient to answer the question of extent of adoption of *STL*. However, in combination, the data are supportive of change taking place. As the choice is made in more and more states, districts, schools, and individual classrooms to orient curriculum and instruction towards the *STL*, the impact on student knowledge and competency will become increasingly evident. This will require, though, continued work in the areas of teacher preparation, professional development, and assessment.

Change in education in America, due to its highly localized nature, can be slow, yet the goal of technological literacy for all Americans appears to be gaining in momentum. Although it may take some time to detect variation in the

pattern of responses on a Gallup Poll of the overall adult population (and even so, it could not be attributed exclusively to the *STL*), enhanced K-12 student achievement will likely be demonstrated more quickly. This standards-based reform effort gives clear evidence of progress.

Dr. Jill F. Russell is the Executive Assistant to the President of Springfield College, Massachusetts.

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