

5. USING TSA TO TEACH THE STANDARDS THROUGH TECH-KNOW

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Rationale for the Study

How do students learn? According to Bransford, Brown, & Cocking (1999), relevance of knowledge, connections between different kinds of knowledge, representations of problems and situations, self-directed inquiry and flexibility of thought, and motivation are often considered as factors affecting this development. Career and Technical Student organizations (CTSOs), like the Technology Student Association (TSA), provide these types of learning opportunities for students enrolled in secondary technology education courses. In 2001, the TECH-know Project initiated its charge to develop instructional materials based on the premise that combining TSA's activities and the *Standards for Technology Literacy (STL)* would provide students a unique and motivational learning experience. Although TECH-know's primary purpose was to develop instructional materials, its process for development and assessment of the materials enabled the project to gain insight related to use of cooperative competition as a way to teach standards. As competitive events have become increasingly popular in education, various qualities have become associated with these events including increased student motivation and the recognition of excellence. Wynne (1995) states, "It is not the winning that counts in these competitions, but the orientation toward excellence and the practice of giving one's best". Wynne (1995) considers cooperative competition to be a strong complement to cooperative learning. By intertwining these elements through TECH-know's instructional materials, teachers are able to teach the standards in an educational and competitive hands-on manner.

Background Information

The TECH-know Project

The TECH-know Project is an instructional materials grant funded by the National Science Foundation (NSF # 0095726). In August 2001, North Carolina State University received a four-year grant from the National Science Foundation to develop standards-based instructional materials for twenty Technology Student Association (TSA) activities. The TECH-know project represented a significant collaboration between selected state departments, universities, businesses, and TSA. From 2001-2004, more than one hundred forty-four technology education teachers, technology teacher educators, TSA Curriculum Resource Committee members, and business representatives from across the country worked together to develop high quality standards-based units of instruction that are based on the *Standards for Technological Literacy*, *National Science Education Standards*, *Principles and Standards for School Mathematics*, and TSA activities. Units were developed based on the following Technology Student Association activities:

High School Activities

Agriculture and
 Biotechnology Design
 Desktop Publishing
 Film Technology
 Manufacturing Prototype
 Medical Technology
 Design
 Robotics RC
 Sci Vis
 Structural Engineering

 System Control
 Technology Challenge

Middle School Activities

Agriculture and
 Biotechnology Challenge
 Cyberspace Pursuit
 Digital Photography
 Dragster Design Challenge
 Environmental Challenge

 Flight Challenge
 Mechanical Challenge
 Medical Technology
 Challenge
 Structural Challenge
 Transportation Challenge

Sixteen of the activities were selected based on their relevance to the standards. Four of the activities were developed by the TECH-know teachers during the first year so that TECH-know units would be reflective of all standards in the STL. The following year, the TSA Curriculum Resource Committee approved the addition of these four competitive activities: Agriculture and Biotechnology Challenge, Agriculture and Biotechnology Design, Medical Technology Challenge, and Medical Technology Design.

In order to address the STL, the TECH-know staff worked to establish a structure within the units that would highlight the strengths of STL and TSA. Sections related to understanding the various technologies associated with each TSA activity were developed, as well as vignettes about science, math, history, and everyday people. The real world connections enable students to relate to the unit's concept and form impressions about technologies instead of just "doing" an activity.

The Technology Student Association

The Technology Student Association (TSA) played a critical role in the development of the TECH-know units. Its activities along with STL laid the ground work for the TECH-know units. Being one of only ten Career and Technical Student Organizations (CTSOs), it is the only student organization dedicated exclusively to students enrolled in technology education classes in grades K-12. TSA serves more than 200,000 secondary students in 2,000 schools in 47 states nationwide. Its mission is to prepare the membership for the challenges of a dynamic world by promoting technological literacy, leadership, and problem solving, resulting in personal growth and opportunity (TSA, 2001b).

According to TSA (2005), its members learn problem-solving, decision-making, critical thinking and leadership skills as they relate to design, communications, power, energy, transportation, engineering, manufacturing, construction and biotechnology. TSA also provides its members with the opportunity to develop leadership and problem solving skills through various avenues including student competitions and leadership opportunities at the

local, state, and national level. Student members also report that their involvement in the TSA activity caused an increase in their understandings of the *STL*'s concepts in select TSA activities (Taylor, 2004). Currently, TSA offers more than fifty middle and high school competitive events representing various areas of technology education, the *Standards for Technological Literacy*, and various leadership skills.

Career and Technical Student Organizations

Career and technical student organizations (CTSOs) originated in the early 1900s after the passage of the Smith-Hughes Act with the mission providing the best learning environment and preparation possible so students can enhance their leadership and technical skill development (Scott and Sarkees-Wincenski, 2004). Over the years, CTSOs evolved and are now recognized as integral part of career and technical education (United States Department of Education, 1999). The co-curricular nature of these organizations enables students to benefit not only in the classroom but also outside the classroom. Benefits of involvement in these organizations can be cited civic responsibility, leadership skills, respect for dignity of work, spirit of healthy competition, and employability skills (Harris and Sweet, 1981; Vaughn 1999). The role these organizations play vary from field to field but it is important to recognize their significance to the field over time and in the future.

Purpose of the Study

Over the past five years, the influence of TECH-know and its materials have been felt throughout the United States. However understanding its significance to the field and significance to TSA and *Standards for Technological Literacy* is important to document, not only for validity of the product but also for the materials validity in the field. The purpose of this study was to show how TSA activities can be used to teach the *Standards for Technological Literacy*. Given this purpose, the following question was generated for this study:

1. Do TSA activities when integrated with TECH-know materials teach the technological concepts found in the *Standards for Technological Literacy*?

Method

From 2001-2005, the TECH-know Project constructed several instruments to assess the effectiveness of its preliminary and final materials, including pretest and posttest based on the STL. During the 2005-2006 school year, approximately 25 schools from various states were asked to field test the TECH-know Project's units. Prior to the field test, teachers at each site were invited to a summer workshop to train them on how to integrate the TECH-know materials and use the TECH-know's evaluation tools in their classroom. Field test teachers were asked to administer the pretests at the beginning of the school year and the posttest following the completion of each unit. Evaluation tools were submitted back to TECH-know staff members in December 2005 for analysis and synthesis.

Instrument Development

Pretest and Posttest Data

The pretest and posttest consisted of 25 multiple choice questions developed and refined during the pilot tests of the TECH-know units. Fifteen of the questions were based on the technological concepts related to the STL in the unit, while the remaining ten questions addressed the mathematical and scientific concepts. The test writing teams used the standards as a guide for developing each unit’s test. The writing team for the tests consisted of experts from science and math, as well TECH-know team members and the pilot teachers.

Standards Matrix Development

During the third and fourth year of the TECH-know project, matrixes were constructed to highlight each of the standards addressed by the each of the twenty TECH-know units. These matrixes were developed after reviewing the completed content by science, mathematics and technology experts in the field. The matrixes show the correlation to the *Standards for Technological Literacy*, *National Science Education Standard*, and *Principles and Standards for School Mathematics*. These matrixes can be found at the conclusion of this paper.

Findings

Data Analysis

To evaluate the findings associated with the pretest and posttest, descriptive and inferential statistics were used. Descriptive statistics consisted of determining through frequency distributions the overall gains in each test. Paired t test was then utilized to determine if there was significance between the pretest and posttest. Hypothesis test results showed statistical significance between sixteen of the twenty units’ pretest and posttest. Paired T statistics in most TECH-know pretest and posttest also showed statistical significance in gains between the pretest and posttest. Administration errors during field testing can be sited as possible sources for lack of significance in identified errors. One unit was omitted due to the inability to read the results. Table 1 lists these findings.

Table 1: Paired T statistics for TECH-know’s field test pre/posttest scores by unit.

| Test Name | Sample Difference | Standard Error | Degree of Freedom | T-Stat | P-value |
|-----------------------------------------------|-------------------|----------------|-------------------|--------|---------|
| Agricultural and Biotechnology Challenge (MS) | -30.52 | 2.69 | 45 | -11.35 | <0.0001 |
| Agricultural and Biotechnology Design (HS) | -25.4 | 3.42 | 19 | -7.42 | <0.0001 |
| Cyberspace Pursuit (MS) | -43.4 | 1.82 | 39 | -23.77 | <0.0001 |
| Dragster Design (MS) | -8 | 1.88 | 55 | -4.25 | <0.0001 |

| | | | | | |
|--------------------------------------------|------------------------|---------------------------|----------------------------------|--------------------|----------------|
| Digital Photography (MS) | -29.31 | 1.76 | 63 | -16.62 | <0.0001 |
| Desktop Publishing (HS) | -42.67 | 4.44 | 23 | -9.60 | <0.0001 |
| Environmental Challenge (MS) | -16.95 | 3.58 | 20 | -4.74 | <0.0001 |
| Flight Challenge (MS) | -23.67 | 4.23 | 23 | -5.60 | <0.0001 |
| Film Technology (HS) | -29.41 | 4.59 | 36 | -6.41 | <0.0001 |
| Mechanical Challenge (MS) | -27.2 | 1.80 | 49 | -15.11 | <0.0001 |
| Medical Technology Challenge (MS) | -39.17 | 2.56 | 71 | -15.28 | <0.0001 |
| Medical Technology Design (HS) | -2 | 4.63 | 9 | -0.43 | 0.68 |
| RC Transportation (HS) | -16.46 | 2.11 | 34 | -7.80 | <0.0001 |
| Structural Challenge (MS) | .2 | 2.07 | 40 | 0.094 | 0.93 |
| Structural Engineering (HS) | -35.2 | 6.50 | 24 | -5.42 | <0.0001 |
| SciVis (HS) | -58.4 | 4.18 | 9 | -13.96 | <0.0001 |
| Transportation Challenge (MS) | 6 | 3.98 | 17 | 1.51 | 0.15 |
| Technology Challenge (HS) | -25.39 | 2.49 | 42 | -10.20 | <0.0001 |
| Overall Difference | Sample Mean | Standard Error | Degree of Freedom | T- Stat | P-value |

| | | | | | |
|-----------------|--------|------|------|--------|---------|
| $\mu_1 - \mu_2$ | -23.93 | 1.07 | 1354 | -22.37 | <0.0001 |
|-----------------|--------|------|------|--------|---------|

Data was also broken down by gender to compare differences between female and males. Both males and females had significant gains. Table 2 lists these findings.

Table 2: Paired T statistics for TECH-know's field test pre/posttest scores by gender.

| Test Name | Sample Difference | Standard Error | Degree of Freedom | T-Stat | P-value |
|-----------|-------------------|----------------|-------------------|--------|---------|
| Female | -24.69 | 1.53 | 241 | -16.11 | <0.0001 |
| Male | -23.5 | 1.10 | 428 | -22.05 | <0.0001 |
| Unknown | -28 | 6.85 | 5 | -4.09 | 0.0095 |

Discussion

After reviewing the findings, it is important to explore what the results of these data might imply. TECH-know pretest and posttest have been used for last four years by more than 144 teachers with more than 5,000 students from across the United States. Each year, gains were shown in most units. With the completion of the project, TECH-know asked the question, can TSA activities when integrated with TECH-know materials be used to teach the standards? The answer is yes and they should be. TSA and the STL curriculum developers should work together through TECH-know and other initiatives so that they might benefit both the technology education teacher and student. TECH-know also supports factors for how people learn by blending the relevance of knowledge, connections between different kinds of knowledge, representations of problems and situations, self-directed inquiry and flexibility of thought, and motivation to student making TSA and the STL stronger.

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