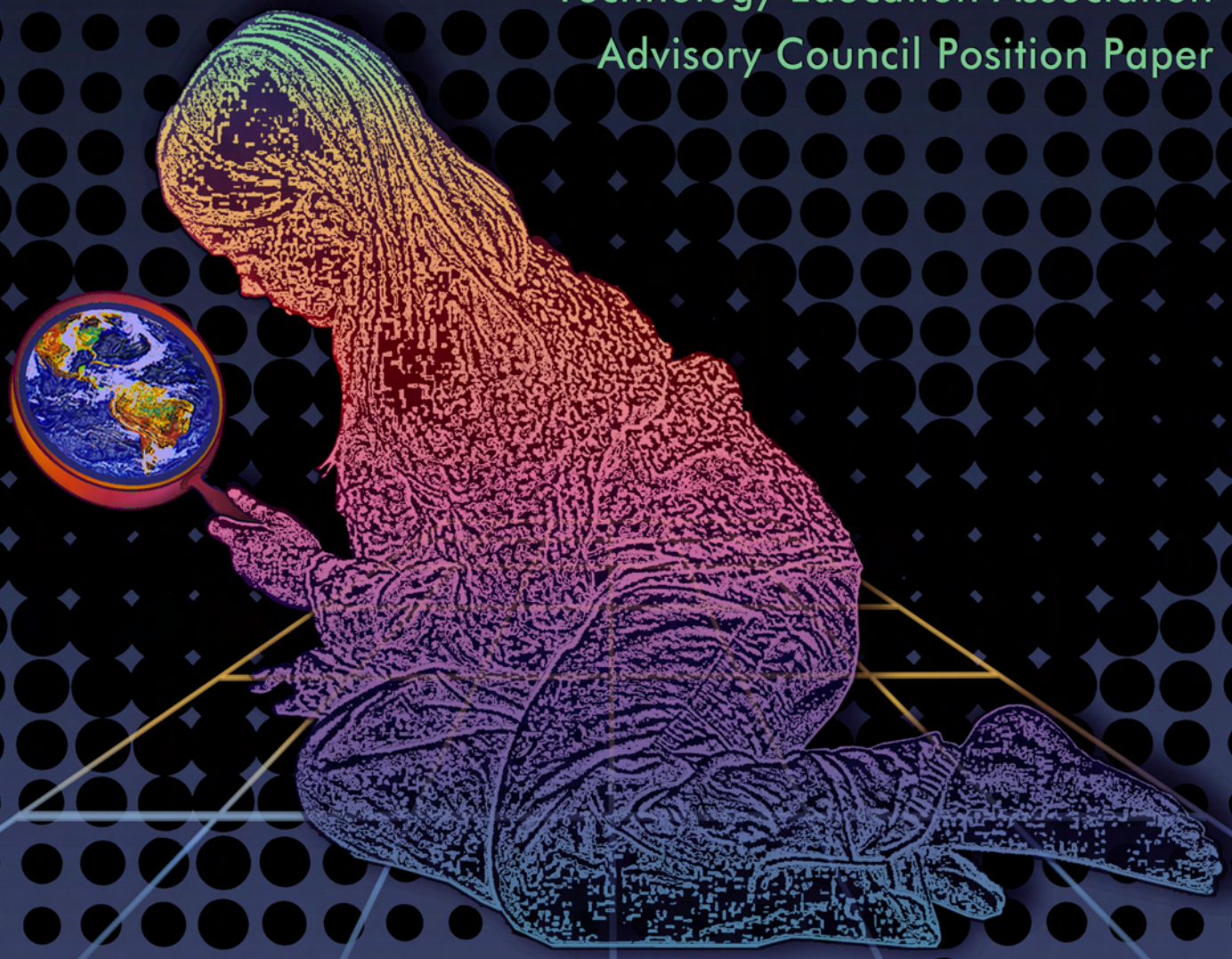
EDUCATING AND ENABLING 21ST CENTURY STUDENTS

New York State
Technology Education Association
Advisory Council Position Paper



NYSTEA

New York State Technology Education Association
Advisory Council

A Position Paper:
Educating and Enabling 21st Century Students

EXECUTIVE SUMMARY

A Global Perspective

According to the National Science Board, "As much as 85% of the measured growth in U.S. income per capita is due to technological change." (2005) Without high-quality, knowledge intensive jobs and the innovative enterprises that lead to discovery and new technology, our economy will suffer and our population will face a lower standard of living.

Comparing the United States mathematics scores and problem-solving skills to 29 other nations, the Organization for Economic Cooperation and Development (OCED) reported that our country ranked 23 out of 29 in 2003. Of the 40 countries that participated in the 2003 Program for International Student Assessment (PISA), the United States ranked 24th in assessment of fifteen year olds' ability to apply mathematical concepts, reading, and science skills to real world problems.

United States Response

With such disquieting analyses in mind, the United States Congress, in 2005, charged the National Academies to respond to the following questions:

1. What are the top ten actions, in priority order, that federal policymakers could take to enhance the science and technology enterprise so that the United States can successfully compete, prosper, and be secure in the global community of the 21st century?
2. What strategy, with several concrete steps, could be used to implement each of those actions?

The National Academies responded with its report *Rising Above the Gathering Storm* that recommended changing high school programs to foster high-quality teaching and utilize world-class curriculum to integrate math, science, and technology education for better understanding.

New York State

New York State Technology Education Association Advisory Council agrees with the National Academy report and joins the members of the American Society of Mechanical Engineers (ASME) in calling for K-12 Science, Technology, Engineering, and Mathematics (STEM) as a priority for action by public policymakers to meet the New York State goal of doubling the number of math, science, and engineering graduates by 2015.

The Advisory Council believes that technology education has a critical role to play in eliminating the gaps in math, science, technological literacy, problem-solving skills, and preparation for all technical fields while serving the needs of all students who are either entering the workforce from high school or continuing into post-secondary education. Expanding the role technology education can serve as an important first step toward addressing New York State's need for a highly qualified workforce as outlined by

the Business Council of New York. This bold step can help ensure that all students achieve technological literacy and skills.

Technology educators have long recognized the need for a relevant pedagogy that focuses on contemporary issues with a learner-centered curriculum; a pedagogy that addresses a diverse student body, encouraging equal participation by females, students of color, and other underrepresented populations.

Recognition and support for teacher recruitment and training ensuring a more diverse teacher population will help students develop intellectual, academic, and life skills preparing them for the 21st century workplace or for post-secondary education.

NYSTEA works in conjunction with the larger professional organization, the International Technology Education Association (ITEA), to integrate its standards into the New York State Learning Standards; standards which deliver a quality programmatic approach through courses with recognizable student outcomes and present authentic problem-solving situations that can be incorporated into curricula in New York schools.

NYSTEA agrees with both the American Society of Mechanical Engineers (ASME) and the Association for Career and Technical Education (ACTE) that it is essential that the 21st century high school model provide students with the expectations, experiences, and skills that adequately prepare them for both college and careers. Technology education can be instrumental in helping high school students realize these important outcomes.

Recapture the Vision and Intent of the MST Standards.

New York needs to embrace, deliver, and assess all seven MST Learning Standards. The critical answer to the question of how to achieve true high school reform and produce technologically capable citizens is incorporated within the rigorous delivery and assessment of all MST Standards. Currently, only two standards, math and science, are consistently taught and assessed. The NYSTEA Advisory Council strongly supports addressing all of the MST Framework components. By doing so, New York students will achieve a greater understanding of all disciplines; be able to exhibit higher levels of learning; become skillful problem solvers; and, recognize and appreciate STEM careers. Technological literacy and technological skills are the keys to connecting all disciplines.

All stakeholders — local school districts, higher education, the private sector, New York State Education Department, NYSTEA, New York State Board of Regents, and the New York State legislature — must work together to:

- Create a new multi-discipline curriculum (STEM)
- Promote discipline specific professional development
- Align pre-service teacher preparation programs with new approaches
- Expand opportunities for collaboration among subject areas
- Pursue partnerships and articulation agreements with post-secondary institutions
- Establish partnerships with the private sector
- Develop strategies for promoting and accomplishing authentic assessment
- Establish advisory committees to support MST collaboration
- Promote differentiated instructional strategies to ensure student access to math, science, engineering, English, history, and technology education

Based on research, professional literature, and support from professional organizations and educators, the NYSTEA Advisory Council offers its position paper for consideration during important discussions of high school reform in New York schools.

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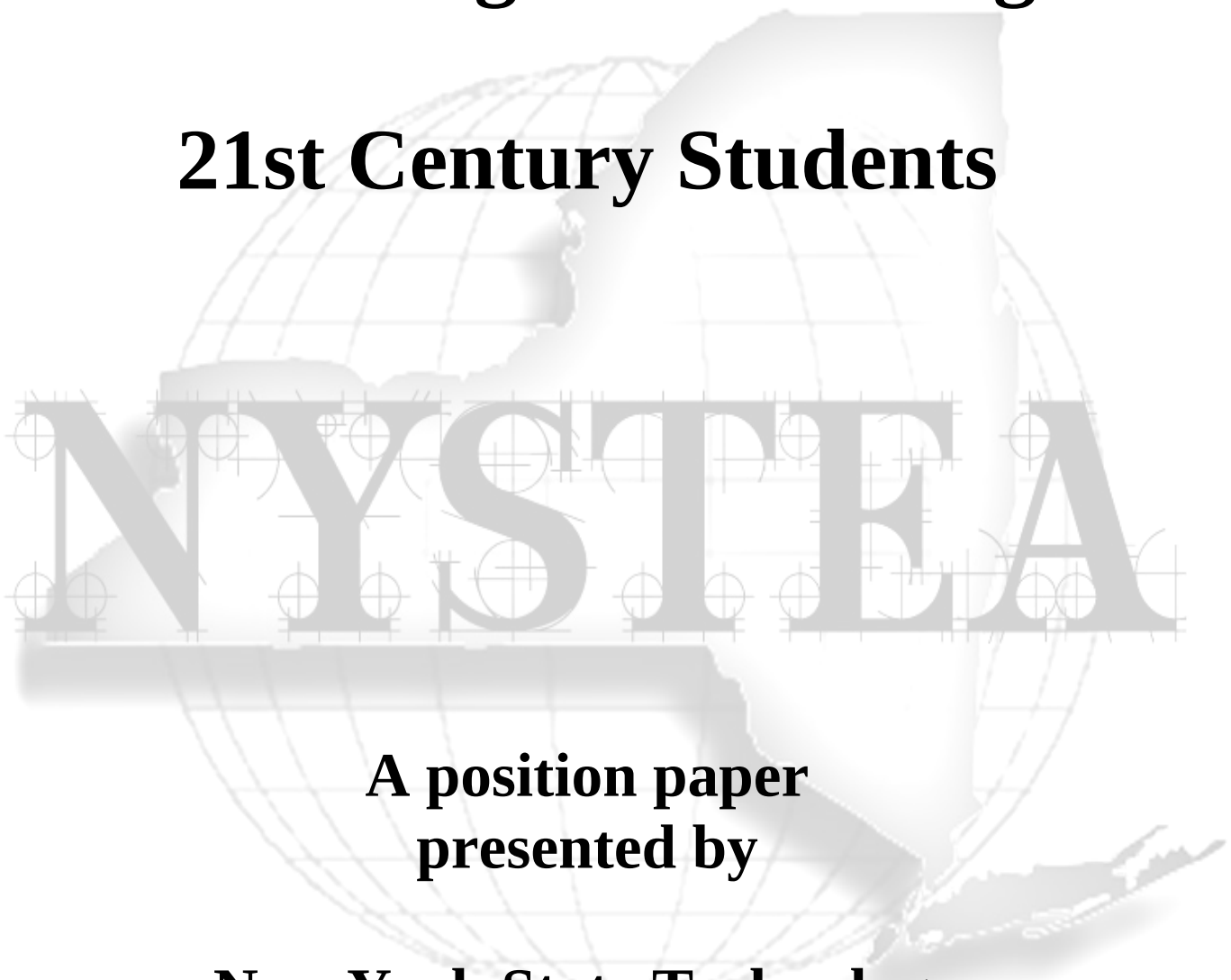

A position paper
presented by

New York State Technology
Education Association
Advisory Council

The New York State Technology Education Association's Advisory Council believes that technological literacy is essential for all students. The Council believes that technological literacy cannot be fully realized without technology education working in conjunction with math, science, and other subjects. As an integral component of education reform, New York State technology education's engaging and interconnected pedagogy can significantly improve learning and help close the achievement gap.

School reform depends on our education community consistently pursuing, utilizing and improving instructional best practices. Students must be empowered with world class intellectual, academic, workplace and life skills. Through technology education's unique learning strategies and real world connections, school reform in New York State can be more readily attained.

In a world permeated by technology, an individual can function more effectively if he or she is familiar with and has a basic understanding of technology. A higher level of technological literacy in the United States would have a number of benefits, for individuals and for the society as a whole:

- Improving Decision Making
- Enhancing Social Well-Being
- Increasing Citizen Participation
- Narrowing the Digital Divide
- Supporting a Modern Workforce

National Academy of Engineering

An historical perspective reveals that many precepts in education are as true today as 100 years ago: pedagogy, problem-solving, diversity, challenge, social justice, literacy, discovery, integration. We can apply this same perspective to the role that technology education has played, plays, and will play in the educational process of young people in this state and nation. The teachings of Edward Austin Sheldon, founder of Oswego Normal School, through "object teaching," encouraged the manual arts movement. We learned from that movement that children learn, retain, and apply lessons that give some physicality to them--learn by doing. The same is as true for the 21st century student as was true for the 19th century student; the difference being content, technological, and pedagogical knowledge have undergone major changes.

With this being said, then what do students need in the 21st century to participate, compete, and live in an increasingly global society? And more importantly how does the technology education discipline meet the needs of the 21st century students? These are the questions that we as educators and policy makers must address to increase the delivery and effectiveness of the discipline.

Closing the Achievement Gap

As educators, we have a responsibility to help students develop skills preparing them for post secondary education or for the world of work in the 21st century workplace. Kati Haycock, director of the Education Trust, reports that New York State "has the biggest gaps in achievement in the entire nation" and is supported by the following data from NYSED:

9th Graders Graduating in Four Years	**Percentages**
Asian	68.8
African-American	45.4
Latino	42
White	81
English Language Learners	34.5
Students with Disabilities	45.9

While student performance in elementary school math improved significantly in 2005-06, achievement in middle school math was mixed. African-American and Latino students have made

some improvements, but those performances in math still lag behind white students. Haycock reports that African-American and Latino 17-year old students do math and read at the same level as White 13-year old students.

Looking at the disparity in achievement levels globally, comparisons of United States math scores to 29 other nations, as reported by the Organization for Economic Cooperation and Development (OCED) reveals that this country ranked 23 out of 29 in 2003. Additionally, in comparisons of problem-solving skills, the United States also ranked 23 out of 29 in 2003. (Haycock 2005)

The United States Congress, in 2005, charged the National Academies to respond to the following questions: What are the top 10 actions, in priority order, that federal policymakers could take to enhance the science and technology enterprise so that the United States can successfully compete, prosper, and be secure in the global community of the 21st century? What strategy, with several concrete steps could be used to implement each of those actions? The National Academies responded with its *Rising Above the Gathering Storm* report. This report recommended changing high school programs to foster high-quality teaching and utilize world-class curriculum to integrate math, science, and technology education for better understanding.

New York has set a goal of doubling the number of math, science, and engineering graduates by 2015. Technology education has a critical and unique role to play in eliminating the gaps in math, science, technological literacy, problem-solving skills, and preparation for all technical fields while serving the needs of all students whether those students are entering the workforce directly from high school or are continuing on to post-secondary education.

Technology educators have recognized the need for relevant pedagogy, contemporary issues, and a learner centered curriculum, which addresses a diverse student population encouraging more participation by females and underrepresented groups. That curriculum must address, in addition to technical knowledge, the following skills that have been identified by employers as expectations for new employees as evidenced by Coplin in his *10 Things Employers Want You to Learn in College*:

- Critical thinking skills
- Collaboration in teams
- Authentic real-world problem solving
- Interpersonal communication skills
- Positive work ethic
- Research skills
- Problem solving

These same skills can apply to high school students as well as college graduates. When high school students master these skills, whether they continue their education or enter the work place, they are better prepared. Skills that have been identified by technology educators, through the New York Technology Education Association, follow the same lines as those expressed by employers including:

Technological literacy
Use of real-world tools
Problem solving
Higher order and critical thinking
Collaboration
Time and resource management
Innovation and creativity
Communications

How, then, can the needs identified by employers and needs identified by educators be addressed by technology education in our schools?

> In addition to creating a technologically literate citizenry, there is an urgent need to develop a technologically capable workforce that can compete in the global economy. Employers are increasingly concerned about the lack of technically skilled workers. Much more emphasis must be placed on pre-college SMET education if this skill deficit is to be overcome.
>
> Susan Skemp, President
> American Society of Mechanical Engineers

> Students must be supported in the acquisition of rigorous core knowledge, skills, habits, and attitudes needed for success in post secondary education and the high-skilled workplace. In addition, students must be engaged in specific career-related learning experiences that equip them to make well informed decisions about further education and training and employment opportunities.
>
> Association for Career and Technical Education
> *Reinventing the American High School* (2006)

The New York State Technology Education Association (NYSTEA) Advisory Council joins other organizations in calling for K-12 Science, Math, Engineering, and Technology Education (SMET) in its priorities for action by public policymakers. Our council believes that initiatives outlined by the Business Council of New York State serve as an important first step to address the state's need for a highly qualified workforce. Our viability, global competitiveness, and security as a state and nation depend on this priority.

NYSTEA agrees with both ASME and ACTE and further concludes that it is essential that the 21st century high school model provide students with the expectations, experiences, and skills that adequately prepare them, in concert, for post-secondary education and careers. Technology education can certainly help high school students realize these important outcomes. NYSTEA works in conjunction with the larger professional organization representing technology educators, the International Technology Education Association (ITEA), integrating its standards into the New York State Standards to deliver a quality programmatic approach; to develop courses with recognizable student outcomes; and, to present authentic problem-solving situations that reinforce and can be incorporated into curricula within New York schools.

Technology Education as a Course of Study

ITEA defines technology as "innovation in action" and technology education as "the study of the human made world". When we combine the two, we find a course of study of the designed world through creativity and innovation. Additionally, ITEA identified the following as technological studies:

- Designing, developing, and utilizing technological systems
- Open-ended, problem-based design activities
- Cognitive, manipulative, and effective learning strategies
- Applying technological knowledge and processes to real world experiences using up-to-date resources
- Working individually as well as in a team to solve problems

According to the New York State Education Department, "technology education provides students with an opportunity to explore a wide range of technology related areas without a focus on specific employment skills. As a bridge between general education and career and technical education, technology education provides students with transferable skills and opportunities to pursue technology areas that may be linked to career and technical education areas. Technology education courses provide students with an awareness of technology in their lives in general and opportunities to pursue a technology related area they may choose as a future career. Career and technical education provides students with specific job skills leading to entry level employment."

NYSED further stated, in 1992, "Our new age of information and technology demands a more highly educated populace and workforce, able to understand the technical complexities which dominate our society. For the United States to remain competitive in world markets, its citizens must be more conversant with technology than ever before." (www.nysed.gov)

Integrative teaching and learning which exists among all disciplines including technology education, math, science, history, and writing arts can be the key to educating that populace. Each discipline supports concepts in the others; thus, all are part of the general education structure and create the whole. Gordon Wilber, in 1948, a strong believer in incorporating industrial arts into general education may have said it best:

> … the first step in the thinking process must be recognition of a problem. It is essential then, that education should continuously face the student with problem situations which require a solution and encourage and allow individual critical thinking.
>
> It appears, therefore, that a close relationship exists between the objectives of general education and the nature of industrial arts.

Even though technology education with its emphasis on problem-based, problem-solving teaching and learning strategies has replaced industrial arts with its project-based emphasis, Wilber's belief in the ***role*** of the discipline in general education is as appropriate as in 1948. Technology education, as a discipline, has answered the call for change and in a contemporary educational setting can be a vital component that supports and is supported by other disciplines.

Technically Speaking: Why All Americans Need to Know More About Technology states: "Technology teachers with a good understanding of science and the interactions between technology, science, and society will be well prepared to work with other teachers to integrate technology with other subjects." (2002) Conversely, science, and history and social studies teachers should be required to acquire knowledge about technology's influences on science and history. (*Technically Speaking*, p.108)

Technology education must be seen as fundamental to achieving workforce competencies, especially when the competencies include critical thinking, solving semi-structured problems, and reasoning.

K. Starkweather, Executive Director
International Technology Education Association
R. Bybee, Executive Director,
Biological Sciences Curriculum Study
The Technology Teacher (2006)

Taken in this context, technology education as general education allows us to see how an environment has been created that allows students to change themselves, to grow independently yet completely, and learn as much or more than what we have historically called *being taught*. This process leads to a more constructivist learning atmosphere in which the learner becomes part of the process rather than just the product of the process. Bain (1999) states, "Students bring paradigms to the class that shape how they construct meaning…a model in which learners do more than accumulate information; they undergo transformations that affect the habits of the heart and mind and the capacity for continued growth." (p.26) In addition, we as educators must recognize that knowledge is more than mastery of content; what to teach and why are equally important as is correlation to students' lives and national and state standards. (Darling-Hammond & Baratz-Snowden, 1995).

Technology education is the perfect medium for creating this kind of learning environment placing learning in context and demonstrating the importance and application of the learning process. Technology education classroom experiences significantly increase academic relevance and technological literacy.

NYSTEA believes students need to process their learning through an integrated performance based approach. This method promotes differentiated instruction which leads to higher levels of learning for all students. Using this approach, students working in teams analyze design solutions which encourage synthesis and evaluation. Students need to utilize mathematics and scientific principles as tools in the problem solving process. In addition, students must become proficient with all methods of communicating, e.g. human to human, written documents, oral presentations, team dynamics, and human to machine.

Reviewing areas of interest in the pursuit of high school reform, technology education as a core course of study can address: 1. setting targets for high school graduation and measuring results; 2. checking teaching qualification ensuring qualified staffs; 3. strengthening teaching through professional development; 4. engaging the public and students; and 5. improving achievement among highest as well as lowest performing students. In addition, the discipline addresses literacy across the curriculum, stresses integration with math and science, and provides the link with career and technical education.

Mathematics, Science, Technology

> Today, it is widely accepted that mathematics, science, and technology are essential to the fundamental education of all students. All children should graduate from high school with among other things, literacy in mathematics, science, and technology.
>
> NYSED
> *Frameworks for Mathematics, Science, and Technology* (1994)

The need for adequate skills, knowledge, and attitudes has been recognized for careers in science, mathematics, and engineering; however, all young people "should be equipped to work in, contribute to, benefit from, and enjoy our technological society. Integrating mathematics, science, and technology and/or connecting one to the other in a planned way with an emphasis on conceptual thinking and problem solving is essential to successful achievement of the standards delineated in this framework. Teaching and learning practices should be congruent with the desire to have citizens participate in a society in which technology is an integral and significant force, both socially and in the workplace." (NYSED, 1994)

Delivering and Assessing All Seven MST Learning Standards – Analysis, Inquiry, and Design, Information Systems, Mathematics, Science, Technology, Interconnectedness: Common Themes, Interdisciplinary Problem Solving

The 1994 *Frameworks for Mathematics, Science, and Technology* states, "Today, it is widely accepted that mathematics, science, and technology are essential to the fundamental education of all students. All children should graduate from high school with among other things, literacy in mathematics, science, and technology. But recent nationwide studies have revealed that America's students are significantly behind other nations in their comprehension of concepts of mathematics, science, and technology, and in skill application and problem solving. In most recent international assessments of educational progress, American students ranked last in mathematics and ninth out of twelve jurisdictions in science. The reasons for studying these disciplines now and in the future have become more significant than in the past, both in New York State and in the nation." (p. 14)

Of the seven New York State Mathematics, Science, Technology (MST) Learning Standards that support the Frameworks statements, only math and science are consistently taught and assessed. The NYSTEA Advisory Council strongly believes that the MST Frameworks design is the correct path to follow. Students can achieve a necessary and greater understanding of all disciplines, be able to think and act at higher levels of learning, become skillful problem solvers, and realize and appreciate Science, Technology, Engineering, and Mathematics (STEM) careers. Technological literacy and skills are ***the*** keys to connecting all disciplines.

A critical response to achieving true high school reform and producing technologically capable graduates is contingent on the rigorous delivery and assessment of ***all seven MST Learning Standards***. To fulfill the vision of these standards, all stakeholders - local school districts, higher education, the private sector, NY State Education Department, NYSTEA, New York State Board of Regents, and the New York State Legislature - can create a professional learning community and accomplish the following:

- Create a new multi-discipline curriculum (STEM)
- Promote professional development as a means of maintaining necessary teaching skills
- Align pre-service teacher preparation programs with new approaches and strategies
- Expand opportunities for collaboration among subject areas
- Pursue partnerships and articulation agreements with post-secondary institutions
- Establish partnerships with the private sector
- Develop strategies for promoting and accomplishing authentic assessment
- Establish advisory committees for supporting and guiding technology and pre-engineering programs
- Promote differentiated instructional strategies to ensure that ***all*** students have access to math, science, engineering, English, history, and technology education.

This, interconnected model will result in not only increased student success in high school courses, but also will improve knowledge and skills for postsecondary education and the workplace.

21st Century Student Skills

To compete in this world, we have to educate a much broader segment of the population at a higher level...We need a fundamental change in attitude away from the elitist assumptions about who can learn, away from the basic strategy of educating a selected population. We must focus on educating all of our children. Furthermore early specialization, say in eighth or ninth grade, is far too early. Students must first be exposed to the exciting and interesting ideas in a broad spectrum of disciplines before they can know what their inclinations might be, before they can make informed judgments about their career choices.

George Campbell Jr., Ph.D.
Meeting the Global Challenge through Education and Innovation
delivered at the New York State Education Summit (2005)

The Advisory Council for NYSTEA believes that all students need to have a command of 21st century skills. Technology education programs can be instrumental in helping student learners achieve these skills with experiences that enable them to transform, expand, and strengthen themselves academically. With increased skills and experiences, high school completers can be viable workers and effective contributors to society. As reported by Ian Jukes in *Education at the Crossroads,* Dr. Milt McLaren from Simon Fraser University, after examining 500 job descriptions in the *Toronto Globe and Mail* in 2005 compiled the most wanted skills by prospective employers as: technological fluency, communications skills, teamwork, information fluency, leadership, problem solving, and creativity. These skills compare to the skills and skill indicators identified by the NYSTEA Advisory Council as keys to success either in post-secondary education or in the workplace.

To illustrate:

A farmer in America, the hero of the agricultural economy, rides in a portable office on his tractor. It's air-conditioned, has a phone, a satellite-driven GPS location device, and sophisticated sensors near the ground. At home, his computer is connected to the never-ending stream of weather data, the worldwide grain markets, his bank, moisture detectors in the soil, digitized maps, and his own spreadsheets of cash flow. Yes he gets dirt under his fingernails but his manual labor takes place in the context of a networked economy. And the skills he needs are very different than those needed by farmers even a few years ago.

Today in the information industry, 44% of all workers and 20% of all paid hours are paid for keyboarding. Consider the impact that PCs have had to date on the information industry. And now, it's about to happen again. Consider for a moment the impact of pen-based and voice input technologies. There is a real danger that a whole sector will be left behind with outdated skills.

Ian Jukes
Education at the Crossroads: New Horizons Part I (2005)

The table on the following page indicates the crosswalk of 21st century skills and skill set indicators identified by New York State technology educators. These skills and indicators correspond to those identified by other professional organizations; however, it should be noted that these skills reinforce both the NYS Learning Standards and ITEA Standards of Technological Literacy as well as disposition factors geared toward good citizenship and professionalism.

NYSTEA Identified 21st Century Skills	NYSTEA Identified Skill Set Indicators
Proficiency with technologies and strategies used to gather, organize, document, and disseminate information	Become an interactive communicator. Exhibit information literacy and practice consumer literacy. Demonstrate visual literacy. Achieve career related (SCANS) skills. Be able to draw conclusions; Exhibit higher order thinking. Develop tactile experiential intelligence. Exhibit curiosity about the designed world.
Consideration of the ethical, environmental, social, and economic impacts of technology in both a local and global society	Be a safe student worker. Practice good citizenship, be socially responsible. Exhibit environmental literacy. Exhibit local and global awareness. Exhibit multicultural literacy. Be personally responsible.
Ability to apply and relate mathematics in the description of the scientific principles that happen naturally in the world and understand technology as the application of these principles to produce goods and services to benefit society	Demonstrate economic literacy. Demonstrate mathematical, scientific, and technological literacy. Learn and work contextually. Demonstrate math, science, and technology language through all forms of communication.
Ability to form groups to facilitate solving complex problems and achieving common goals which are dependent on problem identification, planning, and allocation of resources	Exhibit interpersonal communication skills. Exhibit collaborative communication skills. Prioritize, plan, and manage for results. Show an effective use of real world tools.
Use of established and original problem-solving techniques to become critical thinkers	Participate in problem, project, and experiential based learning. Function well within and between virtual and real worlds. Understand advocacy for themselves and others. Strive to be creative.
Ability to use design as process to analyze and solve problems to greatly improve the quality of, and the speed at which, new products are created	Exhibit problem solving skills. Be adaptable and flexible in common and new situations. Produce high quality prototypes and products.
Ability to continuously self-evaluate to foster personal growth, professional development, and increased employability	Exhibit a belief in self. Be self-directed. Be a risk taker. Be intrinsically motivated. Persist with problem and/or issue solutions. Recognize individual differences and opinion tolerance.

Recommendations

As a result of concern for student learning in the 21st century, research into educational reform, and the importance of meeting global as well as local challenges, the Advisory Council of New State Technology Education Association offers the following recommendations; recommendations to ***key stakeholders*** - *NYSED, NYS Board of Regents, NYS Legislature, NYSTEA, business and industry, school districts and higher education* - that can lead to a more informed cohort of students resulting in a more informed New York citizenry.

Recommendation I: Closing the achievement gap

Establish clear, measurable goals and objectives ensuring that all high school completers receive preparation for post-secondary education or the workplace.

A. Establish programmatic changes incorporating contemporary issues in technology curricula.

B. Consider NYS Learning Standards in total. Show connections among all standards without concentrating on Standard 5 alone.

- Identify math and science in technology curriculums. e.g. machines as scientific inquiry, mathematical reasoning, **and** technological artifact.
- Integrate technology with history and writing arts. e.g. written research on inventions and inventors in an historical setting.
- Infuse core curriculum standards into specific technology unit and lesson planning.
- Establish accountability mechanisms to ensure a greater support, integration, effective delivery, and assessment of New York's MST Standards 1 through 7.
- Re-activate the NYS Grade 8 Technology Education Assessment; include results in local school report cards and at the state level for meaningful data collection and interpretation.

C. Facilitate appropriate applications of ITEA Standards for Technological Literacy.

- Incorporate ITEA standards, which have imbedded within them Interstate New Teacher Assessment and Support Consortium (INTASC) standards with benchmarks for measuring student outcomes.
- Develop assessment instruments and methodologies aligned with standards to determine success of high school completers for college preparation as well as for entry into the workplace.

E. Encourage all students to investigate both career and college preparatory courses as a general education as well as vocational education emphasis.

> …develop a series of carefully constructed or selected multi-year courses. Each of these would give students direct experiences in designing products, structures, and systems to meet individual and social needs.
>
> Raizen, Sellwood, Todd, & Vickers
> *Technology Education in the Classroom: Understanding the Designed World* (1995)

Recommendation II: Student engagement

Establish clear goals and objectives for engaging students.

A. Infuse activities and encourage collaboration with core curriculum teachers.
B. Encourage team teaching. e.g. technology education and language arts work together to produce the newspaper, yearbook, or printed programs for school events.
C. Increase budgets for competitions incorporating technology, art, writing, math, and science. e.g. FIRST (For Inspiration & Recognition of Science & Technology) competitions
D. Increase support for fostering youth leadership through Technology Student Association activities, competitions, and school based technology club activities.
E. Incorporate student participation in professional development activities to increase technology education awareness and create enthusiasm among students interested in entering the teaching profession.

> …the problems we as educators devise for learners should closely approximate a situation in which a scholar, artist, engineer, or other professional attacks a problem.
>
> Wiggins and McTighe
> *Understanding by Design* (1998)

Recommendation III: Student achievement

Establish clear goals and objectives for improved achievement for ***all*** students, not just highest performing students.

A. Encourage problem-solving through hands-on/minds-on experiences for all students.
B. Encourage, through action and funding, authentic learning experiences which transfer to real-world scenarios as opposed to simulated experiences with imagined applications.
C. Integrate technology education in collaborative learning with other disciplines. e.g. creative design activities attract female participation.
D. Develop best practice policies fostering technology education principles and standards.

Recommendation IV: Articulation agreements

Establish clear goals and objectives for improving student success through established articulation agreements between high school technology education programs and two and four year colleges.

A. Develop a model in which high school students are exposed to, complete, and are assessed at the same levels of instructions as the articulating college.
B. Develop a mechanism for teacher preparation to deliver the college level coursework.
C. Provide support to participating school districts and post-secondary institutions to provide a system of checks and balances to monitor the quality and level of instruction provided within the technology programs.

Recommendation V: New, emerging technological challenges

Establish clear goals and objectives for addressing new and emerging technological challenges.

A. Provide additional funding and incentives for incorporating biotechnology, medical technologies, environmentally related technologies, and nanotechnology activities and courses as new technological fields emerge.
B. Update curricula, facilities, and syllabi to reflect emerging technologies that impact the global economy.
C. Reinforce the integration of science and mathematics in the study of new and emerging technologies that can lead to careers such as engineers, technicians, and scientists in the emerging technology fields. e.g. biotechnology, nanotechnology, and environmental science.

Recommendation VI: Literacy across k-12 curricula

Establish clear goals and objectives for addressing literacy across the curriculum and clear cut integration with math and science.

A. Incorporate writing across the curriculum and oral communication plans within schools.
B. Stress reading within the discipline as in general education recognizing that reading and writing should not be confined to language arts courses.
C. Recognize that high school completers should have experienced more than "cut and paste" research that discourages a broad, in-depth, ethical or scholarly approach to literacy, all of which will carry completers through life.
D. Define technological literacy clearly in math, science, and technology curricula so that students and their parents understand the encompassing word, "technology."
E. Integrate technological literacy beginning with math and science in elementary schools.

> Technology education experiences in the elementary school are designed to help children learn and achieve the educational goals of the total elementary school program. These experiences orient pupils to technology, develop psychomotor skill, and provide the basis for informed attitudes about technology's influence on society. Technology-based activities, integrated into the total elementary school curriculum, motivate pupils and reinforce learning while pupils gain a technological awareness.
>
> Virginia Department of Education

Recommendation VII: Teacher qualifications and certification

Establish clear goals and objectives for teacher qualifications meeting certification needs through teacher preparatory programs and alternative routes with support from NYSED.

A. Offer financial incentives to increase numbers of candidates entering ***all*** teacher preparation not just math and science programs.
B. Petition for and help establish a consistent New York State technology education teacher certification process by differentiating between "certified" and "qualified" teachers.
C. Incorporate uniformity in training high school guidance counselors as important stakeholders to support technology related programs and technology education teacher preparatory programs.
D. Strengthen technology education collegiate programs through increased funding and

higher standards to respond to the economic impact of the 21st century global community.

E. Assimilate ITEA standards that serve as guidelines for technology teacher preparatory institution program accreditation by accrediting bodies such as National Council for Accreditation of Teacher Education (NCATE).

Recommendation VIII: Professional development for in-service teachers

Establish clear goals and objectives for continued professional development for teachers.

A. Require school districts to incorporate as many discipline-specific opportunities as possible in their professional development plans.
B. Incorporate student participation in professional development activities to increase technology education awareness and to create enthusiasm among students.
C. Foster cross-discipline professional development opportunities to improve collaboration within the teaching and professional staff.
D. Provide instruction and practice with standards-based assessment tools & methods and data collection & interpretation. e.g. authentic assessment, summative and formative assessments, integrated performance assessment
E. Provide necessary skills and strategy reinforcements to make literacy an essential component through technology education instruction; classroom activities and team collaborative projects should provide significant opportunities for students to strengthen literacy skills.

> Reading and writing in context has proven to be extremely beneficial and effective for student learning and understanding.
>
> Jean Stevens
> NYS Interim Deputy Commissioner of Education (2006)

Recommendation IX: CTE program approval

Establish clear goals and objectives to provide the mechanism for technology education curricula to be evaluated in the approval process provided by Career and Technical Education, Office of Curriculum and Instructional Support.

A. Provide support to technology educators to conduct the study for the approval process for either specialized or integrated courses.
B. Provide support to local school districts for the program approval process stressing the need to address all New York State MST and CDOS Standards as well as ITEA Technological Literacy Standards.
C. Provide mechanisms for measurement and accountability of teacher qualifications to deliver the CTE approved program.

Recommendation X: Career development

Establish clear goals and objectives to provide the link to career and technical education.

A. Reinforce integration of career preparation through core curriculum and the professional community.
B. Provide technical skills for all high school completers through technology education practices.

C. Collaborate with business and industry to increase both knowledge and awareness of the 21st century workplace.
D. Implement instructional strategies to strengthen the delivery of career education links and the Career Development and Occupational Studies Learning Standards (CDOS) to ensure that students can readily make important connections between their learning and the 21st century job marketplace.

> We cannot afford to … talk the same talk about goals, standards, measurements and accountability, or even about the vital issues of teacher quality. All of those are crucially important, for sure, but we must now confront America's economic survival.
>
> N. M. Donofrio
> to the New York State Education Summit (2005)

Support for Recommendations

Technology education programs must stay current with the needs of the world to prepare students to become productive, able citizens for the 21st century. Included in the plan for success, teacher recruitment and preparation are important components that can bring about positive student outcomes. Also important is support from state and local policy makers, administrators, and taxpayers. And, most importantly ***all*** students must realize the significance and impact of technology education on their lives. The following is presented as supporting evidence for the ten recommendations in this paper.

P-16 Strategy

To address the *The Next Stage of Reform: Outline of a P-16 Strategy* report representing the New York State Board of Regents outline for reform, the NYSTEA Advisory Council offers the following response to the strategy: "We will study the practices of high performing education systems, states and nations, and adapt the best to New York's situation. We will try to learn what actions are most effective, and summon others to learn with us." Through research and collaborative efforts with technology educators from other states in the nation, we suggest reviewing the state curricula of Virginia and Pennsylvania. Both have outstanding technology education programs at the elementary, secondary, and post-secondary levels which can serve as benchmarks for New York.

For our purposes, the following are highlights of the two sets of state standards: 1. Virginia has included in its standards framework *Computer/Technology Standards of Learning* five areas of study K-12 : Basic Operations & Concepts, Social & Ethical Issues, Technology Research Tools, Problem-solving & Decision-making Tools, Technology Communication Tools. "The focus is on learning and using technology…developing skills through integrated activities in all content areas K-12…" 2. Pennsylvania combines Science and Technology Standards indicating what students are expected to achieve by the end of grades 4, 7, 10, and 12 broken into Inquiry & Design, Biological Sciences, Physical Science, Chemistry & Physics, Earth Sciences, Technology Education, Technology Devices, and Science, Technology & Human Endeavors. Technology education, computer applications, and science are separate curricular areas.

Again referring to the *Outline of a P-16 Strategy* report's "Actions We Will Take" a second strategy states: "Listen to students, using focus groups and other means, about what's needed to maximize learning for high school graduation and preparation for college, the workforce, and citizenship." We report the following data as support that we ***listened to students***. After careful review, the Advisory Council and Executive Board of NYSTEA believe the data help affirm our unyielding belief in the importance and effectiveness of technology education as a learning discipline.

Technology Education High School Student Survey Participant Data (2005)

Participants	N=1551 - 77.91% male - 22.09% female
Geographic representation	34.24% rural - 24.63% city - 41.13% suburban
High school grade levels	33.53% grade 9 - 25.97% grade 10 24.81% grade 11 - 15.70% grade 12

The following ten pertinent questions from the survey have been identified by the NYSTEA Advisory Council and Executive Board: (Complete survey and data are exhibited in Appendix)

1. The technology education program in my school is beneficial and an important part of my high school experience. 82.78% agree.

2. The technology education hands-on experiences made learning more meaningful or easier for me. 84.39% agree.

3. Technology education provided me with information that I find useful in other courses. 68.33% agree.

4. Technology education has helped me to make my choice for college major or future career. 61.52% agree.

5. My technology education classes helped me to become a better problem solver. 72.91% agree.

6. Technology education has helped me to become more comfortable working among student teams or groups. 70.83% agree.

7. Technology education has improved my ability to choose and apply mathematical principles while working on real life problems. 69.72% agree.

8. Technology education has helped me to better understand myself and my personal abilities. 69.22% agree.

9. Technology education has taught me how to carry out a project or activity related to a certain problem, and how to take the needed steps to solve that problem. 80.98% agree.

10. Technology education has helped me to develop a better understanding of the importance that math and science have in the solving of technological problems. 75.34% agree.

This high school survey was administered during May 2005 to students enrolled in technology education in grades 9 through 12. Students were asked how many technology courses they had taken (ranging from 1 to 5) including the current year. Students accessed the survey electronically through the NYSTEA Website. All data defaulted to the Orleans-Niagara Teacher Center for compilation and interpretation.

Impacts on Student Learning

Ronald Todd states the following based on his research entitled UPDATE (*Upgrading Practice through Design and Technology Engineering Education*):

> Our efforts to understand design, engineering, and technology (DE&T) practice in elementary classrooms in Virginia, Maryland, New York, Ohio, and New Jersey suggest that children provided DE&T activities by their teachers, as compared to children lacking such opportunities, tend to show higher levels of engagement, performance, and empowerment. (2004)

The table below illustrates the indicators identifying engagement, performance, and empowerment.

Student Engagement	Student Performance	Student Empowerment
Improved school attendance	Improved test scores in math, science, and reading	Improved critical thinking and creative problem-solving skills
Increased time-on-task of learning	Improved skills in cooperative team work	Increased willingness of students to take risks and benefit from mistakes
Improved attitude about school and learning	Improved presentation and public speaking skills	Increased willingness of students to take charge of their own learning

Science as a Benchmark

The Science for All Americans Project as reported by Lovedahl in *Journal of Technology Studies* in 2001 reinforces several learning strategies crucial to not only math and science, but also to technology education: engaging students actively, using team approaches, providing experience in using tools, and emphasizing group learning; all support our recommendations in this document. A crosswalk of pertinent science and technology standards is illustrated below:

Science Standards	Standards for Technological Literacy
Be able to make conceptual connections within and across science disciplines, as well as to mathematics, technology, and other school subjects.	Students will develop an understanding of the core concepts of technology. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
Have direct contact with phenomena, gather and interpret data using appropriate technology, and be involved in groups working on read, open-ended problems.	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
Be able to address problems issues, events, and topics that are important to science, the community, and teachers.	Students will develop an understanding of the cultural, social, economic, and political effects of technology. Students will develop an understanding of the influence of technology on history.

Science, Technology, Engineering, Mathematics (STEM)

According to Vernon Ehlers and Mark Udall, members of Congress and co-chairpersons for STEM Education Caucus, "Science and technology underpin our economic strength and national security. Thus, education in the disciplines of science, technology, engineering, and math is critically important to the welfare of our country. We must invest in our children to develop their talent and enable them to compete in the knowledge-based, global economy." (2005) Ehlers and Udall are guiding the move toward implementation of STEM education. Technology educators in New York agree and want to add that much of the STEM education can be delivered through technology education programs as outlined in our

recommendations. With support in both educational infrastructure and professional training and development, technology education in New York State can reassert itself as a national leader in this movement.

Contemporary Issues

Increasingly, Americans are concerned by environmental issues and energy resources. Both NYS and ITEA standards are aligned and support the goal for technology education making possible: technologically literate consumers and citizens. Likewise, since the mapping of the human genome, much is being researched and written about new medical technologies that will extend quality of life.

Technology education has the mechanism in place, through its standards, to address the technologies and their scientific counterparts. Biotechnology and nanotechnology have received a great deal of notice with New York's establishing Centers for Biotechnology and New York State's Nanotechnology Initiatives and will see a need for a larger workforce in both areas. Technology education curricula will need support from the Board of Regents and NYSED to address these contemporary technologies that will become vital to the economy of the state.

Likewise, concern for economic conditions in the U.S. increases the need for educating a technologically literate populace who understands the role of technology in communication, manufacturing, construction, and transportation. Again, standards-based technology education incorporates real world, authentic learning curricula through technology applications that demonstrate influence on economics.

> The technology-driven economy of the 21st century will add about 20 million jobs to the American economy by 2008--if we can only educate our young people to fill them.
>
> George Campbell Jr., Ph.D.
> to the New York State Education Summit (2005)

Collaboration and Support

NYSTEA and individual technology educators must consistently re-affirm the benefits and strengths of technology education to policymakers, education decision makers, and the general public. Through collaboration with similar organizations, we can establish a set of annotated definitions for *technology*, *technology education*, and *technological literacy* to be shared with math and science students. We can re-establish and continue the Math, Science, and Technology Education (MST) Conference bringing together stakeholders in each area to garner support for stronger math, science, and technology education connections. All technology education initiatives reinforcing high school reform needs both philosophical as well as financial support from state and local sources.

General Education - Core Curricula

Math, science, and technology are all important to the general education of all New York State students. In providing content and skills that are taught in a cross curricular and contextual format to all students in the K-12 school, students will have this content reinforced through application in a performance based environment. The occupational plans for the students will also be supported, as called for in the CDOS Standards, with the exposure to a variety of fields of science, technology, and engineering blended into classroom activities.

Final Thoughts

The New York State Technology Education Association offers this document with its recommendations for addressing student, school, and community needs and urges all stakeholders to support the important efforts of this organization and the important role that technology education plays in American society. The program that we know today is deeply rooted in the American educational system and deserves to be preserved and enriched for the future. We should defer to the words of John Dewey, U.S. educator and philosopher: "It is our American habit, if we find the foundations of our education structure unsatisfactory, to add another story or wing. We find it easier to add a new study or course or kind of school than to recognize existing conditions so as to meet the need." Technology education does not need another "study or course or kind of school" to be successful but rather as Dewey says to be recognized as an "existing condition" meeting the needs of American students.

Achieving technological literacy is a purpose statement for technology education.

Starkweather and Bybee
2006

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APPENDIX

Glossary
"This We Believe"
2005 Student Survey
NYSTEA Advisory Council

Glossary

Technology education - A study of technology, which provides an opportunity for students to learn about the processes and knowledge related to technology that are needed to solve problems and extend human capabilities. **Technology education** means a program of instruction designed to assist all students in meeting state intermediate standards for technology. Technology education uses concepts of science, mathematics, social science, and language arts in a hands-on, systems-based approach to problem solving that guides students in the understanding, design and development of systems, devices and products to serve human needs and wants. (NYSED)

Stakeholders - Those who have a share or interest in an enterprise through synergetic efforts in which the combined effect is greater than the sum of the individual effects. Education stakeholders in NY include NYS Education Department, NYS Board of Regents, NYS Legislature, business and industry; local school districts and higher education; taxpayers, parents and guardians; and students.

State learning standards mean the knowledge, skills and understandings that individuals can and do habitually demonstrate over time as a consequence of instruction and experience. (NYSED)

ACTE — Association for Career and Technical Education

ASME— American Society of Mechanical Engineers

CDOS — Career Development and Occupational Studies

FIRST — For Inspiration and Recognition of Science and Technology

INTASC — Interstate New Teacher Assessment and Support Consortium

ITEA — International Technology Education Association

MST — Mathematics, Science, Technology

NCATE — National Council for Accreditation of Teacher Education

NYSTEA — New York State Technology Education Association

OCED — Organization for Economic Cooperation and Development

SCANS — Secretary's Commission on Achieving Necessary Skills

SMET — Science, Mathematics, Engineering, Technology Education

STEM — Science, Technology, Engineer, Mathematics

TSA — Technology Student Association

This We Believe

International Technology Education Association

Technology Education:

Is an essential learning experience for ***all*** students at ***all*** grade levels, abilities, and backgrounds, so that they may confidently use, manage, assess, and understand technology.

Provides the basic knowledge and technical skills needed to participate in society. It increases the economic capacity of nations and allows students to understand and apply advanced technologies so they will be ***prepared for either post-secondary education or entering the workforce.***

Enhances the opportunity for students to develop career awareness or career path preparation. It provides an exposure to a variety of technology related careers - from professional to industrial or service worker. The ***knowledge base learned through technology education*** is important to everyone as all members of society must continually learn in a changing society that is influenced by technology.

Provides for academic, technical, and social growth. It employs involvement with tools, machines, materials, and systems of technology. It enables all students to derive meaning from concrete experiences that result from ***the integration of mathematics, science, humanities, and engineering concepts***. Through direct experience with a wide array of processes, knowledge, and contexts, it helps to develop technological literacy.

Provides a wholesome change in learners by enhancing the understanding of how technology is changing the human-made world and the natural environment. It allows learners to ***experience the activities and habits of a designer, scientist, technologist, engineer, architect, producer, historian, and social critic as they engage in technological problems and issues of the present and future***.

Develops self-evaluation of attitudes toward constructive work and how this work can be used for health, recreation, or economic value. It helps to ***develop favorable attitudes toward creative thinking and to character improvement*** -- knowing and making the most of one's environment.

Requires ***competence, compassion, a desire for excellence, and a vision*** from its educators. Teachers must possess creativity, ingenuity, enjoy working with people, and maintain a high degree of personal and professional integrity.

Technology Education (TE) High School
Student Survey - 2005

1. At what grade level are you now enrolled?
   a) 9th b) 10th c) 11th d) 12th

2. Are you a male or female student?
   a) male b) female

3. Including this year, how many high school technology education (TE) courses have you taken?
   a) 1 b) 2 c) 3 d) 4 e) 5 or more

4. How would you describe the type of school you attend?
   a) rural b) city d) suburban

5. What level of schooling has your parent completed?
   a) Middle school or junior high school
   b) GED
   c) High School
   d) 2 year technical school
   e) 4 years of college
   f) More than 4 years of college

Please complete the following statement by **selecting all that apply**

6. I have taken a technology class because

   a) a fellow student/friend recommended it.
   b) a guidance councilor recommended it.
   c) a parent or family member felt it would helpful.
   d) the topics are interesting and challenging.
   e) it is easier to do well in then other courses.
   f) the material or content is interesting.
   g) it provided college credit.
   h) it fulfilled a 3rd year of science OR math credit.
   i) it fulfilled a required art credit.
   j) I like working with your hands
   k) I am interested in engineering or other technical fields.
   l) I am using it as a 5 unit high school sequence.

Please answer the following technology education (TE) related statements with Strongly Agree / Agree / Disagree / Strongly Disagree

7. The TE program in my school is beneficial and an important part of my high school experience.

8. The TE classroom materials were current and appropriate for the class.

9. The TE teachers are knowledgeable in the courses I took.

10. The TE hands-on activities made learning more meaningful or easier for me.

11. TE has provided me with information that I find useful in other courses.

12. TE has helped me to make my choice for a college major or future career.

13. TE has helped me to be a better consumer/purchaser of products.

14. TE has helped me to develop a better understanding of government and economics.

15. TE has helped me to become a better problem solver.

16. TE has helped me to become more comfortable working among student teams or groups.

17. TE has helped me to develop a better understanding of the importance math and science has in the solving of technological problems.

18. TE has helped me to better understand myself and my personal abilities.

19. TE has provided me with the opportunity to teach others new ways to do things.

20. TE has improved my ability to choose and apply mathematical principles while working on real life problems.

21. TE has taught me how to make graphic or 3-D model to show how to control a system or device, and how to collect information on how well it performs or works.

22. TE has taught me how to begin and carry out a project or activity related to a certain problem, and how to take the needed steps to solve the problem.

23. TE has taught me how to select the right tools, instruments, and equipment for a project, problem or activity.

24. TE has taught me how to use tools and equipment correctly while working with materials, energy, and the available information.

25. TE has helped me to understand the application of inventions and how they influence our economy and the environment.

26. Technology plays a large role in our everyday lives.

27. The use of technology can have both good and bad results.

28. Science and technology approach problems in identical ways.

29. Engineering and engineering technology are the same fields of study.

30. Engineering and technological problem solving methods are basically the same.

31. Design is a process that can be used to turn ideas into products.
32. Most environmental problems can be solved through the use of technology.

33. It is important to know how to develop solutions to identified problems.

34. It is important to know how and when to apply math, science and technology skills.

35. In today's world, it is important to be technologically literate as well as an able consumer and worker.

In the space below, please write a few thoughts about how technology education has impacted you and your future.

2005 High School Survey Responses
1551 Eligible Respondents

Question 1 N=1548 Respondents
grade level
1-1 33.53% 9th
1-2 25.97% 10th
1-3 24.81% 11th
1-4 15.70% 12th
0.19% NA

Question 2 N=1544 Respondents
gender
2-1 77.91% male
2-2 22.09% female
0.45% NA

Question 3 N=1544 Respondents
number of TE courses
3-1 30.05% 1
3-2 27.07% 2
3-3 16.71% 3
3-4 13.73% 4
3-5 12.44% 5 or more
0.45% NA

Question 4 N=1539 Respondents
4-1 34.24% rural
4-2 24.63% city
4-3 41.13% suburban
0.77% NA

Question 5 N=1535 Respondents
parental level of schooling
5-1 2.74% Middle school or junior high school
5-2 2.61% GED
5-3 32.83% High School
5-4 9.45% 2 year technical school
5-5 35.37% 4 years of college
5-6 17.00% More than 4 years of college
1.03% NA

Question 6 N=1532 Respondents
reason(s) for taking TE class
6-1 29.31% a fellow student/friend recommended it.
6-2 29.05% a guidance councilor recommended it.
6-3 24.28% a parent or family member felt it would helpful.
6-4 59.60% the topics are interesting and challenging.
6-5 28.20% it is easier to do well in then other courses.
6-6 59.01% the material or content is interesting.
6-7 28.85% it provided college credit.
6-8 6.79% it fulfilled a 3rd year of science OR math credit.
6-9 32.64% it fulfilled a required art credit.
6-10 45.17% I like working with my hands
6-11 54.31% I am interested in engineering or other technical fields.
6-12 16.91% I am using it as a 5 unit high school sequence.
1.23% NA

Question 7 N=1545 Respondents
TE program is beneficial
7-1 42.59% 4 Strongly Agree
7-2 40.19% 3
7-3 12.88% 2
7-4 4.34% 1 Strongly Disagree
0.39% NA

Question 8 N=1544 Respondents
TE classroom materials were current…
8-1 51.23% 4 Strongly Agree
8-2 37.95% 3
8-3 7.45% 2
8-4 3.37% 1 Strongly Disagree
0.45% NA

Question 9 N=1538 Respondents
TE teachers are knowledgeable
9-1 58.91% 4 Strongly Agree
9-2 28.67% 3
9-3 7.48% 2
9-4 4.94% 1 Strongly Disagree
0.84% NA

Question 10 N=1537 Respondents
TE hands-on activities
10-1 48.67% 4 Strongly Agree
10-2 35.72% 3
10-3 10.93% 2
10-4 4.68% 1 Strongly Disagree
0.90% NA

Question 11 N=1528 Respondents
information useful in other courses
11-1 29.19% 4 Strongly Agree
11-2 39.14% 3
11-3 22.71% 2
11-4 8.97% 1 Strongly Disagree
1.48% NA

Question 12 N=1531 Respondents
helped choose college major/career
12-1 30.76% 4 Strongly Agree
12-2 30.76% 3
12-3 23.45% 2
12-4 15.02% 1 Strongly Disagree
1.29% NA

Question 13 N=1525 Respondents
better consumer/purchaser
13-1 19.34% 4 Strongly Agree
13-2 31.28% 3
13-3 30.82% 2
13-4 18.56% 1 Strongly Disagree
1.68% NA

Question 14 N=1532 Respondents
better understanding of government
14-1 12.34% 4 Strongly Agree
14-2 23.96% 3
14-3 34.99% 2
14-4 28.72% 1 Strongly Disagree
1.23% NA

Question 15 N=1528 Respondents
better problem solver
15-1 32.40% 4 Strongly Agree
15-2 40.51% 3
15-3 16.69% 2
15-4 10.41% 1 Strongly Disagree
1.48% NA

Question 16 N=1530 Respondents
comfortable working in teams
16-1 31.63% 4 Strongly Agree
16-2 40.20% 3
16-3 18.10% 2
16-4 10.07% 1 Strongly Disagree
1.35% NA

Question 17 N=1533 Respondents
importance of math and science
17-1 36.59% 4 Strongly Agree
17-2 38.75% 3
17-3 16.18% 2
17-4 8.48% 1 Strongly Disagree
1.16% NA

Question 18 N=1530 Respondents
better understand self
18-1 30.59% 4 Strongly Agree
18-2 38.63% 3
18-3 20.20% 2
18-4 10.59% 1 Strongly Disagree
1.35% NA

Question 19 N=1516 Respondents
opportunity to teach others
19-1 31.60% 4 Strongly Agree
19-2 37.14% 3
19-3 20.78% 2
19-4 10.49% 1 Strongly Disagree
2.26% NA

Question 20 N=1529 Respondents
choose & apply mathematical principles
20-1 30.35% 4 Strongly Agree
20-2 39.37% 3
20-3 20.80% 2
20-4 9.48% 1 Strongly Disagree
1.42% NA

Question 21 N=1536 Respondents
make graphic or 3-D model
21-1 45.70% 4 Strongly Agree
21-2 32.10% 3
21-3 13.54% 2
21-4 8.66% 1 Strongly Disagree
0.97% NA

Question 22 N=1519 Respondents
begin and finish a project
22-1 40.95% 4 Strongly Agree
22-2 40.03% 3
22-3 12.90% 2
22-4 6.12% 1 Strongly Disagree
2.06% NA

Question 23 N=1522 Respondents
select the right tools
23-1 41.59% 4 Strongly Agree
23-2 38.24% 3
23-3 14.45% 2
23-4 5.72% 1 Strongly Disagree
1.87% NA

Question 24 N=1528 Respondents
use tools and equipment correctly
24-1 42.74% 4 Strongly Agree
24-2 37.17% 3
24-3 13.15% 2
24-4 6.94% 1 Strongly Disagree
1.48% NA

Question 25 N=1530 Respondents
understand the application of invention
25-1 31.24% 4 Strongly Agree
25-2 42.81% 3
25-3 18.50% 2
25-4 7.45% 1 Strongly Disagree
1.35% NA

Question 26 N=1529 Respondents
technology plays a large role
26-1 70.11% 4 Strongly Agree
26-2 20.73% 3
26-3 5.30% 2
26-4 3.86% 1 Strongly Disagree
1.42% NA

Question 27 N=1531 Respondents
technology can have good & bad results
27-1 59.70% 4 Strongly Agree
27-2 28.87% 3
27-3 7.32% 2
27-4 4.11% 1 Strongly Disagree
1.29% NA

Question 28 N=1528 Respondents
sci & tech approach problems identically
28-1 32.07% 4 Strongly Agree
28-2 43.00% 3
28-3 18.00% 2
28-4 6.94% 1 Strongly Disagree
1.48% NA

Question 29 N=1525 Respondents
engineering = engineering technology
29-1 22.30% 4 Strongly Agree
29-2 41.05% 3
29-3 25.84% 2
29-4 10.82% 1 Strongly Disagree
1.68% NA

Question 30 N=1532 Respondents
engineering & technological problem-solving
30-1 24.93% 4 Strongly Agree
30-2 46.15% 3
30-3 20.63% 2
30-4 1.29% 1 Strongly Disagree
1.23% NA

Question 31 N=1532 Respondents
design turns ideas into products
31-1 52.28% 4 Strongly Agree
31-2 35.77% 3
31-3 8.36% 2
31-4 3.59% 1 Strongly Disagree
1.23% NA

Question 32 N=1531 Respondents
environmental problem solutions
32-1 31.68% 4 Strongly Agree
32-2 42.85% 3
32-3 19.53% 2
32-4 5.94% 1 Strongly Disagree
1.29% NA

Question 33 N=1525 Respondents
importance of developing solutions
33-1 51.21% 4 Strongly Agree
33-2 34.95% 3
33-3 9.97% 2
33-4 3.87% 1 Strongly Disagree
1.68% NA

Question 34 N=1532 Respondents
math, science, technology application
34-1 57.31% 4 Strongly Agree
34-2 30.68% 3
34-3 7.44% 2
34-4 4.57% 1 Strongly Disagree
1.23% NA

Question 35 N=1530 Respondents
important to be technologically literate
35-1 60.00% 4 Strongly Agree
35-2 29.80% 3
35-3 5.88% 2
35-4 4.31% 1 Strongly Disagree
1.35% NA

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