

# The Power and Promise of Technology and Engineering Education

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## Introduction

It is a pleasure to be here today and to have an opportunity to talk about technology and engineering education as a part of teaching technological literacy. I will talk about technological literacy as one subject area and bring attention to the increasingly important role that it plays in our society as well as how it affects our everyday existence.

Technology and technological literacy have been described in many ways. But most definitions concur that technological literacy is used to make our lives better, more productive, or more enjoyable. In itself, technology can be rigid and inhuman. It offers no solutions. However, when managed, technology is flexible. When understood, it can be adapted and changed as needed—or wanted. Many educators think of technology and technological literacy as applied mathematics and science for specific purposes. Those purposes have also been described as the use of knowledge, tools, and skills to increase our potential, to solve problems, and to modify our world.

The issue is not whether technology or engineering is good or bad; not whether it should or shouldn't be offered; or not how it is to be taught. The main issue here is whether any nation can maintain a worldwide competitive edge without appropriate understandings and education pertaining to technological literacy—understandings that result in the level and quality of living that we desire. Therefore, this presentation is about providing a type of education that will help our citizens live optimally in an advanced technological society.

## Defining Technological Teaching

Educators often only link technology and technological literacy to the use of computers and the education pertaining to teaching **with** technology. Technological literacy is teaching **about** technology. We must consider all types of technologies that relate to our designed world. That designed world may include medical, agricultural and related bio-technologies, energy and power technologies, information and communication, transportation, manufacturing, construction technology, and more. To only think of technology in terms of delivering instruction is a short-sighted view.

Technological literacy has its own content base, which often is not fully understood or considered by educators. That content base has to do with the nature of technology, technology and society, design, abilities for a technological world, and the designed world.

It is important to describe the difference between the teaching of science and technology. Science education has traditionally been known to teach about the natural world through observation, identification, description, experimental investigation, and theoretical explanations. Scientific inquiry is a key method of learning science through the use of questioning and close examination using the methodology of science.

Technology and engineering education provides opportunities to learn about the processes and knowledge related to technology that is needed to solve problems and extend human capabilities. Technology has been defined as human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities. Design is the key method used in teaching about technology (ITEA/ITEEA, 2000/2002/2007).

Science education does not automatically teach about technology any more than technology and engineering education automatically teaches about science. The two subjects have distinct differences in their ways of thinking, content addressed, and importance as a part of the general background of all students.

### **Technological Literacy Content**

Our association is currently working to advance science, technology, engineering, and mathematics (STEM) teaching with an emphasis on technology and engineering. We see the subjects working together to create an education that will produce the next generation of technology and engineering thinkers.

Imagine a simple three-legged stool with each leg representing the subject areas of mathematics, technology, and science, and with the seat of the stool representing engineering. This practical way of thinking about the interaction and relationship of these school subjects also shows us that each subject is important for the content and way of thinking that it presents to the student.

Our association has used these ideas to develop a curriculum for technological literacy to be taught as a separate subject in our schools starting at the earliest levels and continuing through high school. The curriculum was developed as a result of several steps that included a major national project to create *Standards for Technological Literacy: Content for the Study of Technology*.

Our first step was the creation of *A Rationale and Structure for the Study of Technology* (ITEA/ITEEA, 1996). This work allowed ITEEA to look and study in detail such topics as the need for technological literacy in our schools, the processes of technology, what technology teaching would look like, and a call for action across our country.

A complete set of standards followed the development of the *Rationale* that described what all students should know and be able to do pertaining to technology at the following four grade

levels: K-2, 3-5, 6-8, and 9-12. These resulting standards have been translated into Chinese, Japanese, Estonian, German, and Finnish languages. The Table of Contents shows that five major areas have been identified, with 20 major standards noted as important to the study of technology. The chapters are as follows:

- Preparing Students for a Technological World
- Overview of *Standards for Technological Literacy*
- The Nature of Technology
- Technology and Society
- Design
- Abilities for a Technological World
- The Designed World
- Call to Action

A subsequent major effort created three additional sets of standards in a publication titled *Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards* (ITEA/ITEEA, 2003). These standards developed research-based principles, practical contexts, students as learners, curricula and programs, instructional strategies, and continued professional growth and learning environments, and were created to assist teachers with being better educators of technological literacy.

### **A Curriculum to Reflect Technological Teaching**

At this point in our effort to create a new direction, we found it necessary to build courses that were based upon the sets of standards. Today, we have a comprehensive set of K-16 courses that reflect standards in science, technology, engineering, and mathematics called Engineering byDesign. The goals of this curriculum effort are to:

- Provide a standards-based K-12 program that ensures that all students are technological literate.
- Provide opportunities for ALL students.
- Provide clear standards and expectations for increasing student achievement in STEM subjects.
- Provide leadership and support that will produce continuous improvement and innovation.
- Provide a program that constructs learning from a very early age and culminates in a capstone experience that leads students to become the next generation of engineers, designers, innovators, and technologists.

Today, ITEEA has units for young children containing standards-based content, suggested testing, and the ability to refine and assess technological designs.

A few selected titles and descriptions are as follows:

- **Invention:** Students develop an idea for an invention by designing and constructing a working model or prototype of a gadget.
- **Communication:** Students examine communication processes, design, and develop a commercial project promoting school spirit.
- **Power and Energy:** Students gain an understanding of wind energy as they construct a device that captures wind energy and converts it to electricity.
- **Mechanical Toys:** Students investigate two mechanical devices and design a toy that uses both to create movement.

Today, ITEEA has numerous courses and complete curriculum guides that are used by teachers ([www.iteea.org](http://www.iteea.org)).

A few selected titles:

- *Exploring Technology*
- *Invention and Innovation*
- *Foundations of Technology*
- *Technological Issues and Impacts*
- *Technological Design*
- *Engineering Design*

We also have specialized sets of courses on the following topics:

- Robotics, Engineering, and Automation
- Modeling and Simulation
- Science and Engineering

All of these materials can be accessed online once the teacher or his or her school becomes a part of a purchased funding source. Approximately 20 of the 50 U.S. states are involved in this effort, which includes online learning, assessments, and a community of learners.

### **Building Ongoing Success**

Building ongoing success in student learning is the result of key educational components that strengthen the school subject. Such success is no different when it comes to teaching about technological literacy. The following are key components that are offered to bring attention to the factors that will nurture technological literacy into becoming a stronger subject in a school system in any country.

### ***Political Support***

Innovation, invention, technological know-how, and the ability to problem solve will not blossom and grow like a flower in any educational system unless the citizens and elected or selected political officials have a real desire to create such an education. To teach technological literacy as a component of another subject, such as science, is a way to initially introduce the subject to students. However, if this kind of thinking is perpetuated, technological literacy will be considered less important than other subjects. Technological literacy will only be considered important when it is taught as a separate subject. Therefore, it is important that technological literacy have advocates at key political and educational levels to allow the subject to blossom like all other school curriculum subjects. Relegating technological literacy to a less important role in a school curriculum will impede the students' ability to know and use technology, innovation, design, and engineering, which will lead to slower progress technologically by our next generation of thinkers.

### ***Teacher Preparation Institutions***

Specific professional development must be provided to teachers, including knowledge, abilities, and understandings consistent with technological literacy content. Therefore, professional development should center on understanding the nature of technology, recognizing the relationship between technology and society, knowing the attributes of design, and developing abilities for a technology world. The teacher must be provided with educational perspectives on students as learners of technology, design practitioners, creators and problem solvers using technology, and more. Model teaching practices should be features in all teacher-preparation programs. In other words, the teacher-preparation institutions are key to having strong technological literacy programs as they provide the leadership in thought and practice.

### ***Understandings of Technological and Design Thinking***

Most educators in my home country do not understand that to have a population of next-generation technological thinkers and innovators, you need to teach more than just mathematics and science. Technology and engineering put mathematics and science into action and cause human innovation to take place. While mathematics and science rely on facts and principles, technology and engineering are dynamic in nature, always changing as new ideas are created and better ways to advance technology are applied. Design is the key factor in understanding the application of technology and engineering. The design and engineering processes are different ways of thinking about content that is not taught in any other school subject. The reason that science, technology, engineering, and mathematics are considered to be a single unit is because the interaction of these subjects calls for the use of each subject while each has a uniqueness to bring to the total relationship.

### ***Dynamic Technological Content***

As noted in *Standards for Technological Literacy*, humans have been called the animals that make things, and at no time in history has that been as apparent as the present. Today, every human activity is dependent upon various tools, machines, and systems, from growing food and

providing shelter to communication, healthcare, and entertainment. Technological literacy is the subject area that addresses content that is like water in that it can be slow or fast-moving, used in work or recreation, can be helpful or harmful to your health, and be either very simple or sophisticated in nature. Therefore, we are dealing with dynamic or ever-moving content that is created by humans who are involved in “human innovation in action.” No other school subject deals with content that is as dynamic as this subject area. The result is open-ended learning that allows for maximum creativity on the part of the student, where the teacher is the manager of activities rather than the user of limited exercises, and where the student is not limited by what the teacher knows. The dynamic nature of this subject area is why we have so many people involved in creating devices, making new things possible, and doing what humans have never been able to do before.

### ***Research-Supported Teaching Learning***

We cannot advance excellence in technological literacy unless there is an assessment of student learning that is consistent with the goals or standards that are to be attained. Restated, we must have assessment of student learning that will match the intended purpose. This means that we must have a specific statement of purpose related to the content for the study of technological literacy. The purpose must be followed with fair and equitable student assessment methods with valid and reliable data measurements that are reflective of classroom experiences. Teaching and learning assessments must be systematic and derived from research-based assessment practices found to be successful with other educational subjects. However, due to the unique character of technology and engineering courses, a variety of technological assessment and performance-based methods must be utilized.

### ***Facilities that Allow the Ability to Design and Construct***

The majority of school systems in the United States have facilities or student learning environments in which to practice design and construction. These facilities are supportive of student interactions and abilities to question, inquire, design, invent, and innovate. The facility helps to promote student development of knowledge and abilities and provides for the safe application of appropriate technological tools, machines, materials, and processes. Therefore, technology students have a learning environment that allows them to practice the design and engineering processes that enable them to create and construct.

### **Summary**

I hope that I have given you ideas to think about during our few moments together. One of humankind’s biggest challenges is to make our world work in a way that sustains everything that is wonderful about this planet. To do so will take a special kind of skill. Some call it design and technological problem-solving. It is real solutions for the real world. We call it technology and engineering education.

The challenge to implement the appropriate technology and engineering curriculum into our school systems is a difficult one regardless of the country in which we live. I wish you success with your efforts to improve your technology and engineering programs and hope that we can continue to gain from our interaction with each other.

## References

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**Dr. Kendall N. Starkweather** is the Executive Director/CEO of the International Technology and Engineering Educators Association and has held that position for over 30 years. His previous teaching experience has been at the high school and university levels. He is the publisher of the association's journals, *Technology and Engineering Teacher* and *Children's Technology and Engineering*. This presentation was made in Beijing, China in December, 2011.