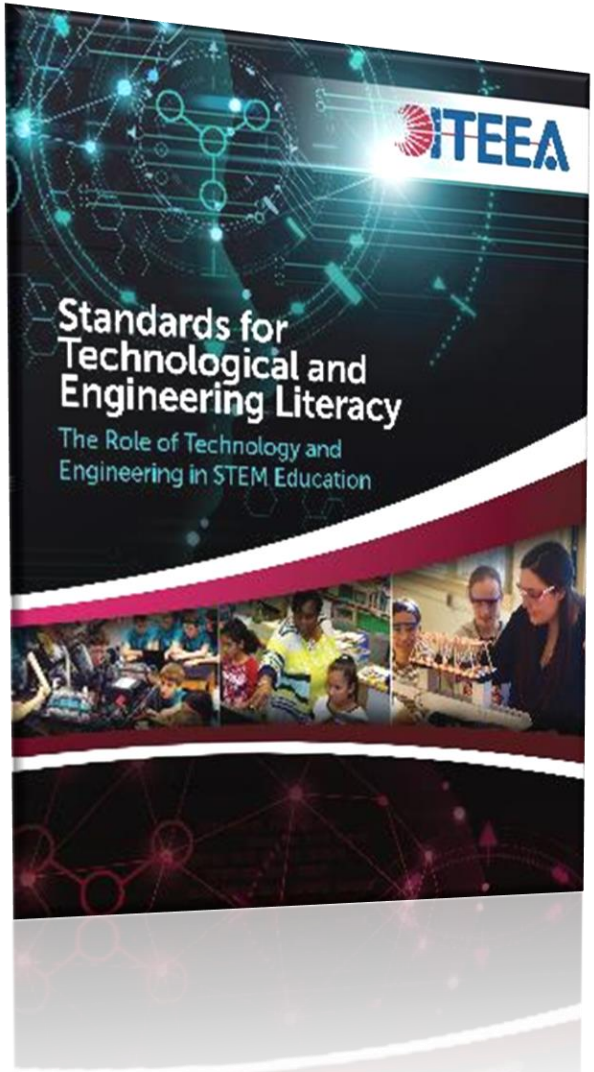

Standards for Technological and Engineering Literacy

The Role of Technology and Engineering in STEM Education

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The Importance of Technology and Engineering

- Educators and members of the public realize that K-12 students need to have fundamental literacies in technology and engineering.
- Many students lack technology and engineering experience.
- TEE programs deliver an integrated, design-based approach to teaching and learning.

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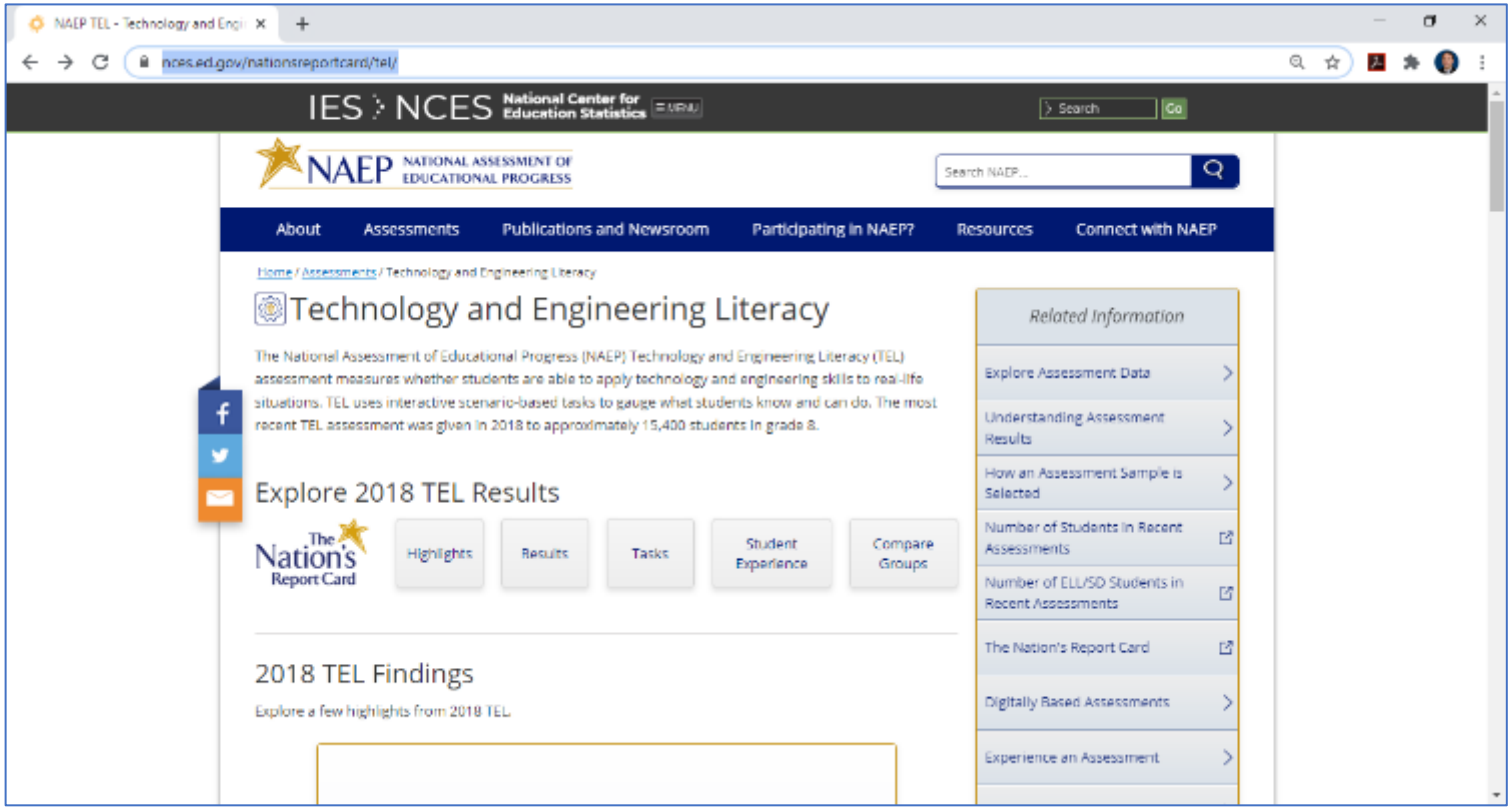
The National Academies of SCIENCES ENGINEERING MEDICINE

The Importance of Technology and Engineering Education

- https://nces.ed.gov/nationsreportcard/tel/



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Redefining Technology and Engineering

- Technology and engineering education programs deliver an integrated, design-based approach to teaching and learning.
- Formal technology and engineering education courses are not available in all schools.
- Students are graduating with a minimal understanding of one of the most powerful forces shaping society today.

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Three Dimensions of Technology and Engineering Education

- **Knowing:** taking in information, organizing it, and understanding factual and conceptual relationships
- **Thinking:** making sense of information through questioning, analysis, and decision making.
- **Doing:** using technology and engineering in applied ways such as designing, making/building, producing, and evaluating.

Technology and Engineering in STEM

- STEM is a unitary force that must be addressed effectively.
- Technology and engineering are traditionally underrepresented in this disciplinary quartet.
- *Standards for Technology and Engineering Literacy* is designed to help educators better understand technology and engineering education and how to teach it.

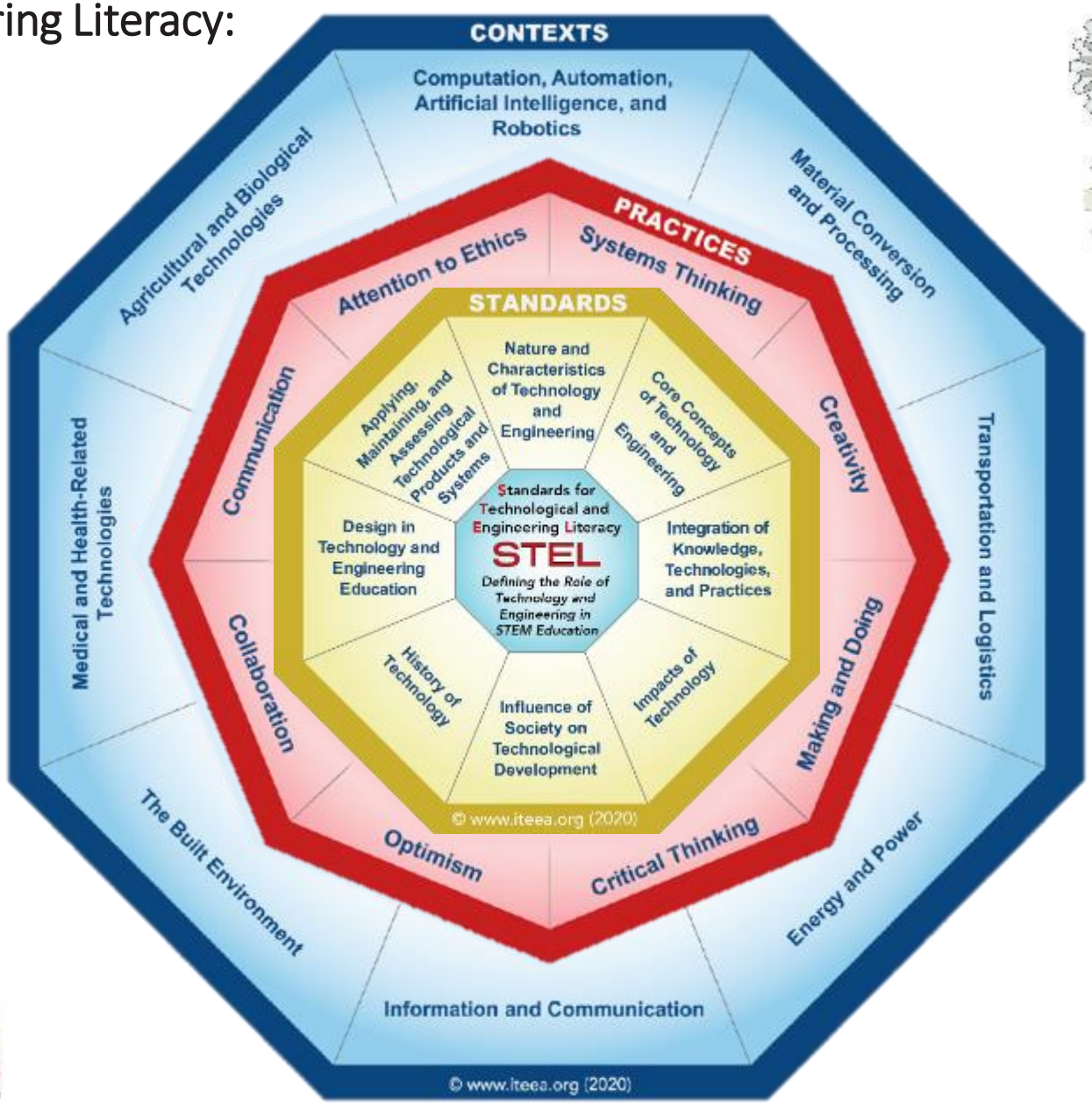
Focus on the Small “e” in engineering

- *STEL* does not attempt to encompass the full spectrum of engineering content.
- Engineering (noun) – the disciplinary study of engineering.
- Engineering (verb) – the use of engineering design and application of engineering habits of mind.

Features of *STEL*

- It offers a common set of expectations for what students in technology and engineering STEM laboratory-classrooms should learn through the dimensions of knowing, thinking, and doing.
- It is developmentally appropriate for students.
- It provides a basis for the creation of meaningful, relevant, and articulated curricula at the national, state/provincial, and local levels.
- It promotes interdisciplinary connections with other school subjects in Grades PreK-12.

Basic Structure of Standards for Technological and Engineering Literacy:



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STEL Core Disciplinary Standards

Based on the concept of power standards, *Standards for Technological and Engineering Literacy* presents eight core disciplinary standards with 142 benchmarks, linked to Grades Pre-Kindergarten through 12. What students should know and be able to do in order to be technologically and engineering literate.

Format of the Core Standards

Each core disciplinary standard follows this format:

- Number and title of the standard
- A narrative explaining the standard's intent
- Grade-level material for Grades PreK-2, 3-5, 6-8, and 9-12
- Key ideas
- Benchmarks that detail the particular knowledge, skills, and dispositions that students must attain in order to meet the standard

Benchmarks

- Identify the fundamental content elements needed for students to meet each standard.
- Objectives written with active verbs that outline the knowledge, skills, and dispositions that enable students to meet each of the standards at the PreK-2, 3-5, 6-8, and 9-12 grade bands.
- Followed by supporting sentences that provide further detail, clarity, and examples.

Technology and Engineering Practices

Student-centered practices that reflect the skills and abilities students will use to successfully apply core disciplinary standards in the different contexts.

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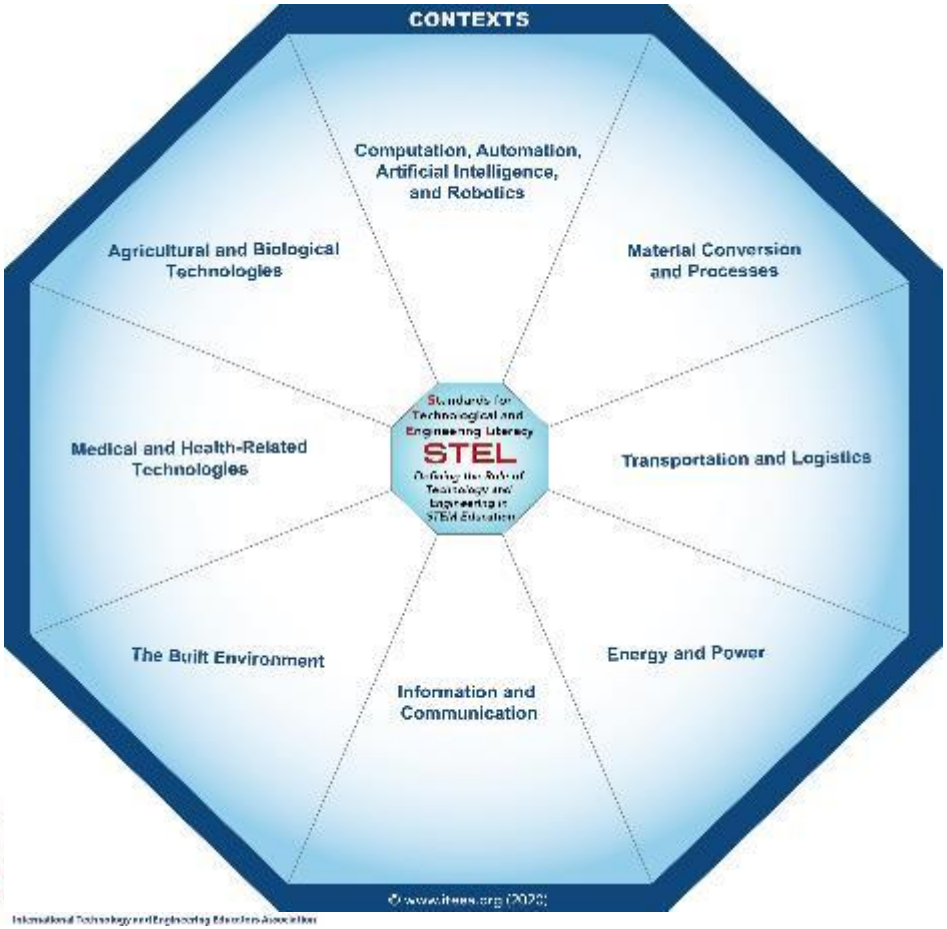
TEE Standards and Practices

- All students should study all standards and practices but not necessarily every context.
- Standards and practices are not taught in isolation, there is often overlap.

Technology and Engineering Contexts

The technology and engineering contexts presented in *STEL* describe the settings where the core disciplinary standards and benchmarks are best taught or applied.



Grades 3-5 Technology and Engineering Context in Computation, Automation, Artificial Intelligence, and Robotics: Third graders can apply STEL-4F: Describe the helpful and harmful effects of technology in a national curriculum on stability and motion that includes programming. These students identify technologies in their world that use automation or artificial intelligence and discuss both positive and negative impacts that could result. To elicit further thinking, students should identify these impacts and suggest potential solutions when designing a system that would utilize automation or artificial intelligence. This example can be linked to TEP-7: Communication.

Relationships among domains of learning, dimensions of TEE, and student outcomes

Domains of Learning	Technology & Engineering Dimensions	Student Outcomes (as defined by Benchmark verbs)
Cognitive →	Knowing & Thinking →	Knowledge
Psychomotor →	Doing →	Skills
Affective →	Knowing, Thinking, & Doing →	Dispositions

Standard Descriptions & Key Ideas

an alphanumeric listing (e.g., STEL-1A, STEL-6B, STEL-7C) and are highlighted in bold type. They are followed by supporting sentences (not in bold) that provide further detail about how the benchmarks can be implemented in order for students to meet the standards.

Standard 1: Nature and Characteristics of Technology and Engineering

The words *technology* and *engineering* have many meanings and connotations, some of which were defined and explained in Chapter 1. In order to build a foundation for the study of technology and engineering, students must first gain an understanding of the nature and characteristics of these disciplinary fields. These foundational understandings can then be expanded upon to develop the knowledge, skills, and dispositions that are associated with technological and engineering literacy.

Three key ideas clarify the nature and characteristics of technology and engineering. The benchmarks that follow all link back to these key ideas, with increasing levels of specificity and complexity across the grade bands. The first key idea is that **the study of technology and engineering requires knowledge of the natural world and the human-made world.** Students learn that there are similarities and differences between the natural world and human-made world and that changes in one can have intended and unintended impacts on one or both. A firm understanding of this first key idea will lead to advanced concepts such as designing to imitate nature (biomimicry) and design for sustainability.

A second key idea is that **the study of technology and engineering as a human activity is interdisciplinary.** Many connections have been drawn between science, technology, engineering, and mathematics. However, each discipline brings unique characteristics to STEM education:

- *Technology* is the modification of the natural environment through human-designed products, systems, and processes, to satisfy needs and wants.
- *Engineering* is the use of scientific principles and mathematical reasoning to optimize technologies in order to meet needs that have been defined by criteria under given constraints.
- *Science* involves investigation and understanding of the natural world.
- *Mathematics* enables communication and critical analysis and is how we make sense of the human and natural world using numbers and computational reasoning.

The study of technology and engineering draws upon knowledge, tools, and processes from across the human experience. This can refer to the processes by which knowledge is obtained and through which technological products and systems are created. It can also be used very broadly in reference to an entire system of products, knowledge, people, organizations, regulations, and social structures (e.g., the technology of the electric grid, or the entirety of the internet).

Although they have some unique characteristics, the design processes used in technology and engineering are similar to the discovery and design processes embedded within other disciplines.

Grade Band Descriptions & Benchmarks

with tourists and spread diseases worldwide. When problems like this arise, leaders often look globally to see if other societies have encountered and solved similar problems.

To demonstrate their understanding of the influence of society on technological development, students in Grades 6-8 should be able to:

STEL-5F. **Analyze how an invention or innovation was influenced by its historical context.** Characteristics of technologies are the result of the circumstances in which they are developed. Economic, political, cultural, and environmental drivers create historical contexts and determine the design of technology and its level of acceptance. For example, over the past decade, lighting technology has evolved considerably, with LED bulbs largely replacing both incandescent and compact fluorescent lighting as a result of people seeking more efficient, long-lasting, and more environmentally benign lighting solutions.

STEL-5G. **Evaluate trade-offs based on various perspectives as part of a decision process that recognizes the need for careful compromises among competing factors.** Technological developments come with both benefits and consequences. A trade-off is a compromise in which one thing is given up in order to get something else that is desired. Students should recognize that a society's expectation for new and unique products contributes to design for obsolescence and to unsustainable rates of consumption.

Grades 9-12

Technology is influenced by society's institutions, including governmental, business, and educational institutions, among others. These societal institutions impact how people learn, live, work, and play. Students in Grades 9-12 need to realize the influence of society on technology and how societal decisions can directly affect the development of a product or system.

Students should study how public opinion directly affects the marketplace. When a product or system is not regarded favorably, the developers must decide whether to continue, to modify, or to halt its development. Moral and ethical considerations also play a role. Acceptance or rejection by society often determines the success or failure of new technologies.

To demonstrate their understanding of the influence of society on technological development, students in Grades 9-12 should be able to:

STEL-5H. **Evaluate a technological innovation that arose from a specific society's unique need or want.** As engineers modify technological systems, materials are often chosen based on local environmental factors, locally available materials, and cost. Modes of transportation differ depending upon population density, availability, safety, speed, geography, and

Recommendations for Using *STEL*

The benchmarks specify how students progress toward technological and engineering literacy and what students need to know and be able to do in order to meet the standards.

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Convert Benchmarks to Instructional Objectives

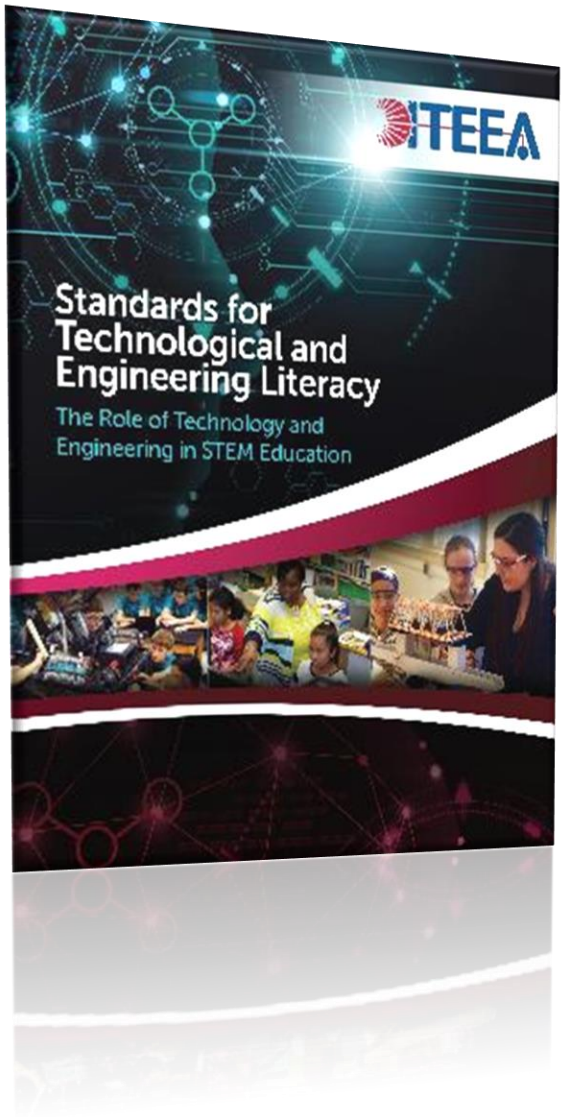
The ABCD method of writing objectives : A is for audience, B is for behavior, C is for conditions, and D is for degree of mastery

STEL

To demonstrate their understanding of the influence of society on technological development, students in Grades 9-12 should be able to:
STEL-5H. Evaluate a technological innovation that arose from a specific society's unique need or want.

Objective

Given a country, the student will evaluate a technological innovation that arose from a specific society's unique need or want and has been adopted by most of the people in that country.



Call to Action

TECHNOLOGY is the modification of the natural environment, through human designed products, systems, and processes, to satisfy needs and wants.

ENGINEERING is the use of scientific principles and mathematical reasoning to optimize technologies in order to meet needs that have been defined by criteria under given constraints.

TECHNOLOGICAL AND ENGINEERING LITERACY is the ability to understand, use, create, and assess the human-designed environment that is the product of technology and engineering activity

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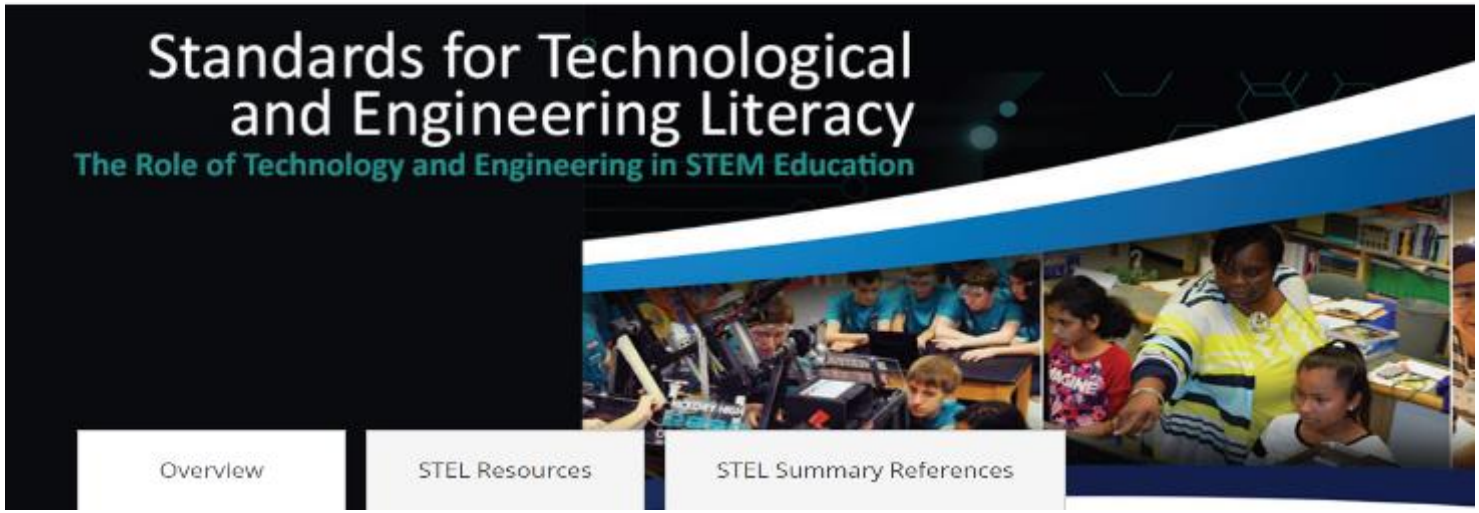
STEL Collaborations

1. Help move your school system toward a PreK-12 technology and engineering program for all students.
2. Show your colleagues the logical and authentic connections between and across the individual STEM disciplines.
3. TEE should serve as a bridge to STEM careers.

Standards for Technological and Engineering Literacy: Defining the Role of Technology and Engineering in STEM Education (STEL)



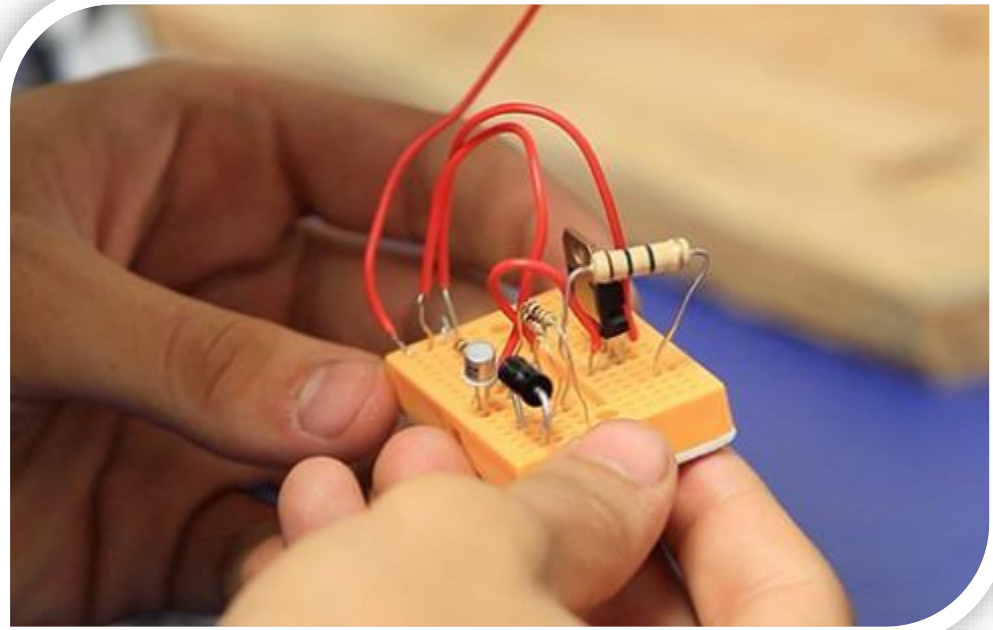
Accessing *STEL*

STEL is Available in the following formats:

- Downloadable/Viewable PDF (FREE)
- Downloadable/Printable PDF
- EPub Edition
- Print Edition
- Interactive Website (coming soon)

Additional STEL Resources

- Benchmark Crosswalks to other standards
- Marketing resources,
- Benchmark compendiums by grade band
- Benchmark verb matrix connecting to the domains of learning
- And more…



Visit www.iteea.org/stel.aspx

STEL Benchmark Crosswalk to NGSS and CCSS Benchmarks: Valid Matches

5/11/2020

Grade Band	STEL Benchmark	NGSS (2013)	CCSS Math	CCSS ELA
	STEL 1 Nature and Characteristics of Technology and Engineering			
Pre-K-2	**1A.** Compare the natural world and human-made world.	**K-2-ETS1-1** Ask questions based on observations to find more information about the natural and/or designed world(s).	**K.MD.2.** Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference.	ELA-Literacy.SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood.
Pre-K-2	**1B.** Explain the tools and techniques that people use to help them do things.		**1.MD.4** Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points.	
Pre-K-2	**1C.** Demonstrate that creating can be done by anyone.	**ETS1.A** A situation that people want to change or create can be approached as a problem to be solved through engineering.	**K.G.5**. Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.	ELA-Literacy.W.K.2 Use a combination of drawing, dictating, and writing to compose informative /explanatory texts in which they name what they

https://www.iteea.org/File.aspx?id=175089&v=48757a07

Standard 1: Nature and Characteristics of Technology and Engineering

https://www.iteea.org/File.aspx?id=175128&v=1ace7ee6

Key Ideas:
- The study of technology and engineering requires knowledge of the natural world and the human-made world.
- The study of technology and engineering as a human activity is transdisciplinary.
- The study of technology and engineering involves the ability to understand, use, assess, and create products, systems, and ways of thinking.

Band	Benchmark		Cognitive	Affective	Psychomotor	Knowledge Dimension
P-2	A	Compare the natural world and human-made world.	Evaluate			
	B	Explain the tools and techniques that people use to help them do things.	Understand			
	C	Recognize that creating can be done by anyone.	Understand	Receiving		Conceptual
	D	Discuss the roles of scientists, engineers, technologists, and others who work with technology.	Understand	Responding		
3-5	E	Compare how things found in nature differ from things that are human-made, noting differences and similarities in how they are produced and	Evaluate			
	F	Describe the unique relationship among science and engineering, and how the natural world can contribute to the human-made world to foster	Understand			
	G	Differentiate between the role of scientists, engineers, and technologists related to creating and maintaining technological systems.	Analyze			
	H	Design and build solutions by safely using tools, materials, and skills.			Practicing	
	I	Explain how solutions to problems are shaped by economic, political,	Understand			
6-8	J	Develop innovative products and systems that solve problems and extend capabilities based on individual or collective needs and wants.	Create		Adapting	
	K	Compare and contrast the contributions of science, engineering, mathematics and technologists in the development of technological	Analyze			
	L	Investigate how technology and engineering are closely linked to creativity, which can result in both intended and unintended innovation.	Evaluate	Responding		
	M	Apply creative problem-solving strategies to the improvement of existing devices or processes or the development of new approaches.			Practicing	
9-12	N	Explain how the world around them to guide technological development and engineering design.	Understand			
	O	Assess similarities and differences among scientific, mathematical, engineering, and technological knowledge, and the skills that contributed to a product or system design.	Evaluate	Responding		
	P	Analyze the rate of technological development and predict future diffusion.	Evaluate	Responding		
	Q	Conduct research to inform intentional inventions and innovations that address specific needs and wants.	Analyze		Practicing	
	R	Develop and implement a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system.	Create		Practicing	

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