# SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) INTEGRATION

In recent years, not only educators, but also political, civic, and industry leaders have pushed for a greater emphasis on STEM education in schools. It is globally recognized that in order for any nation to be competitive, our future generations must develop competency in the 21st century skills afforded through STEM fields. TSA promotes a vision of students literate in these fields and believes competitions within this guide help make that vision a reality.

STEM education is not just an isolated and discreet acquisition of STEM knowledge and skills. Rather, STEM education demands the interdisciplinary application of these academic fields to improve outcomes in comprehension, communication, and problem solving. It is commonly accepted that the correlation between these STEM disciplines is interdependent. In order to develop a deep comprehension of one STEM area, one must simultaneously have an encompassing knowledge of another. For example, to design and engineer with any degree of complexity, one also must be familiar with technology, mathematics, and science. To practice science, one must have a firm knowledge of mathematics and technology.

Beyond necessity, there is another reason for STEM education in our schools and why the TSA program of activities inherently aligns with STEM goals. This reason revolves around teaching, learning, and what motivates our 21st century learners.

When students participate in TSA competitions, they find they must not only embrace the value of design when they compete, but they also must conceptualize, assess, and materialize that vision. Students may choose to work collaboratively, depending upon the requirements of an event, or they may choose to work independently.

Irrespective of this choice, students develop the essential leadership and critical thinking skills to execute their strategy and align their intention with the STEM objectives set forth in this guide. STEM education is intrinsically exciting, rewarding, and meaningful for instructors and students alike. Through TSA competitive events, instructors challenge students to solve real-world problems through project-based learning and reflective experiences. This rigorous process supplements and complements classroom objectives by asking students to critically evaluate all aspects of their thought processes—from design, to communication, to execution.

Deserving of mention are three other essential areas embedded in most of TSA's competitive events—creativity, innovation, and ethics. Teaching students to think outside the box while considering the ethical consequences provides a global perspective essential to the success of our society. Through TSA competitions, students are asked to design creatively, while assessing the effects and impacts of what they develop.

The competitions found in this guide provide a hands-on venue for learning about STEM. By participating in TSA's competitive events, students gain a broader understanding of these content areas as they experience the satisfaction that comes from applying them to real life, problem-solving situations.

*This section of the guide includes commonly accepted national standards for the areas of science, technology, and mathematics, as well as the Accreditation Board for Engineering and Technology (ABET, Inc.) criteria for accrediting higher education engineering programs.*

## NEXT GENERATION SCIENCE STANDARDS* (GRADES 9-12)

### A. Structure and Properties of Matter

1. **PS1-1:** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
2. **PS1-3:** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
3. **PS1-8:** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
4. **PS2-6:** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

### B. Chemical Reactions

1. **PS1-2:** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
2. **PS1-4:** Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
3. **PS1-5:** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
4. **PS1-6:** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
5. **PS1-7:** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

### C. Forces and Interactions

1. **PS2-1:** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration
2. **PS2-2:** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
3. **PS2-3:** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*
4. **PS2-4:** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects
5. **PS2-5:** Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

### D. Energy

1. **PS3-1:** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
2. **PS3-2:** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
3. **PS3-3:** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*
4. **PS3-4:** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics)

5. **PS3-5:** Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

### E. Waves and Electromagnetic Radiation

1. **PS4-1:** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media
2. **PS4-2:** Evaluate questions about the advantages of using a digital transmission and storage of information.
3. **PS4-3:** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
4. **PS4-4:** Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
5. **PS4-5:** Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*

### F. Structure, Function, and Information Processing

1. **LS1-1:** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells
2. **LS1-2:** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
3. **LS1-3:** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

### G. Matter and Energy in Organisms and Ecosystems

1. **LS1-5:** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
2. **LS1-6:** Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
3. **LS1-7:** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
4. **LS2-3:** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
5. **LS2-4:** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
6. **LS2-5:** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

### H. Interdependent Relationships in Ecosystems

1. **LS2-1:** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
2. **LS2-2:** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
3. **LS2-6:** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
4. **LS2-7:** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*

5. **LS2-8:** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
6. **LS4-6:** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*

### I. Inheritance and Variation of Traits

1. **LS1-4:** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms
2. **LS3-1:** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring
3. **LS3-2:** Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
4. **LS3-3:** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population

### J. Natural Selection and Evolution

1. **LS4-1:** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
2. **LS4-2:** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
3. **LS4-3:** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait
4. **LS4-4:** Construct an explanation based on evidence for how natural selection leads to adaptation of populations
5. **LS4-5:** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

### K. Space Systems

1. **ESS1-1:** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.
2. **ESS1-2:** Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
3. **ESS1-3:** Communicate scientific ideas about the way stars, over their life cycle, produce elements.
4. **ESS1-4:** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

### L. History of Earth

1. **ESS1-5:** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
2. **ESS1-6:** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
3. **ESS2-1:** Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

### M. Earth's Systems

1. **ESS2-2:** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
2. **ESS2-3:** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection

3. **ESS2-5:** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
4. **ESS2-6:** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere..
5. **ESS2-7:** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

## N. Weather and Climate

1. **ESS2-4:** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
2. **ESS3-5:** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

## O. Human Sustainability

1. **ESS3-1:** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activitity.
2. **ESS3-2:** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*
3. **ESS3-3:** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
4. **ESS3-4:** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
5. **ESS3-6:** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

## P. Engineering Design

1. **ETS1-1:** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
2. **ETS1-2:** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
3. **ETS1-3**: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
4. **ETS1-4**: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Although not formally aligned, this standards alignment of TSA competitve events has been developed in accordance with the Next Generation Science Standards (NGSS) model.

*The Next Generation Science Standards (NGSS) were developed by educators, content experts and policymakers, using as a guiding document the Framework for K-12 Science Education from the National Research Council. The Next Generation Science Standards is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards were involved in the production of this product, and do not endorse it.

| NEXT GENERATION SCIENCE STANDARDS (GRADES 9-12) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Event | Standard Number | A-PS1-1 | A-PS1-3 | A-PS1-8 | A-PS2-6 | B-PS1-2 | B-PS1-4 | B-PS1-5 | B-PS1-6 | B-PS1-7 | C-PS2-1 | C-PS2-2 | C-PS2-3 | C-PS2-4 | C-PS2-5 | D-PS3-1 | D-PS3-2 | D-PS3-3 | D-PS3-4 | D-PS3-5 | E-PS4-1 | E-PS4-2 | E-PS4-3 | E-PS4-4 | E-PS4-5 |
| Animatronics | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Architectural Design | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biotechnology Design | | | | | X | | | | | | | | | | | | | | | | | | | | | | |
| Board Game Design | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coding | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Architecture | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Computer Integrated Manufacturing (CIM) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cybersecurity | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Data Science and Analytics | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Debating Technological Issues | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Digital Video Production | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dragster Design | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Engineering Design | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Essays on Technology | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extemporaneous Speech | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fashion Design and Technology | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Flight Endurance | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Forensic Science | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Geospatial Technology | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Music Production | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| On Demand Video | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Photographic Technology | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Prepared Presentation | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Promotional Design | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scientific and Technical Visualization (SciVis) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Software Development | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Structural Design and Engineering | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| System Control Technology | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transportation Modeling | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Video Game Design | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Webmaster | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## NEXT GENERATION SCIENCE STANDARDS (GRADES 9-12) – continued

| Event | Standard Number | F-LS1-1 | F-LS1-2 | F-LS1-3 | G-LS1-5 | G-LS1-6 | G-LS1-7 | G-LS2-3 | G-LS2-4 | G-LS2-5 | H-LS2-1 | H-LS2-2 | H-LS2-6 | H-LS2-7 | H-LS2-8 | H-LS4-6 | I-LS1-4 | I-LS3-1 | I-LS3-2 | I-LS3-3 | J-LS4-1 | J-LS4-2 | J-LS4-3 | J-LS4-4 | J-LS4-5 |
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| Animatronics | | | | | | | | | | | | | | | | | | | | | | | | | |
| Architectural Design | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biotechnology Design | | | X | | | | | | | | | | | X | | X | | | | | | | | | |
| Board Game Design | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coding | | | | | | | | | | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Architecture | | | | | | | | | | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | | | | | | | | | | | | | | | | | | |
| Computer Integrated Manufacturing (CIM) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cybersecurity | | | | | | | | | | | | | | | | | | | | | | | | | |
| Data Science and Analytics | | | | | | | | | | | X | X | X | | X | | | | | | | X | | | X |
| Debating Technological Issues | | | | | | | | | | | | | | | | | | | | | | | | | |
| Digital Video Production | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dragster Design | | | | | | | | | | | | | | | | | | | | | | | | | |
| Engineering Design | | | | | | | | | | | | | | | | | | | | | | | | | |
| Essays on Technology | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extemporaneous Speech | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fashion Design and Technology | | | | | | | | | | | | | | | | | | | | | | | | | |
| Flight Endurance | | | | | | | | | | | | | | | | | | | | | | | | | |
| Forensic Science | | | | | | | | | | | | | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | | | | | | | | | | | | | | | | | | | | | | | |
| Geospatial Technology | | | | | | | | | | | | | | | | | | | | | | | | | |
| Music Production | | | | | | | | | | | | | | | | | | | | | | | | | |
| On Demand Video | | | | | | | | | | | | | | | | | | | | | | | | | |
| Photographic Technology | | | | | | | | | | | | | | | | | | | | | | | | | |
| Prepared Presentation | | | | | | | | | | | | | | | | | | | | | | | | | |
| Promotional Design | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scientific and Technical Visualization (SciVis) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Software Development | | | | | | | | | | | | | | | | | | | | | | | | | |
| Structural Design and Engineering | | | | | | | | | | | | | | | | | | | | | | | | | |
| System Control Technology | | | | | | | | | | | | | | | | | | | | | | | | | |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transportation Modeling | | | | | | | | | | | | | | | | | | | | | | | | | |
| Video Game Design | | | | | | | | | | | | | | | | | | | | | | | | | |
| Webmaster | | | | | | | | | | | | | | | | | | | | | | | | | |

## NEXT GENERATION SCIENCE STANDARDS (GRADES 9-12) – continued

| Event | Standard Number | K-ESS1-1 | K-ESS1-2 | K-ESS1-3 | K-ESS1-4 | L-ESS1-5 | L-ESS1-6 | L-ESS2-1 | M-ESS2-2 | M-ESS2-3 | M-ESS2-5 | M-ESS2-6 | M-ESS2-7 | N-ESS2-4 | N-ESS3-5 | O-ESS3-1 | O-ESS3-2 | O-ESS3-3 | O-ESS3-4 | O-ESS3-6 | P-ETS1-1 | P-ETS1-2 | P-ETS1-3 | P-ETS1-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Animatronics | | | | | | | | | | | | | | | | | | | | | | | | |
| Architectural Design | | | | | | | | | | | | | | | | | | | X | X | | X | | |
| Biotechnology Design | | | | | | | | | | | | | | | | | | | X | | X | X | X | |
| Board Game Design | | | | | | | | | | | | | | | | | | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | | | | | | | | | | | | | | | |
| Coding | | | | | | | | | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Architecture | | | | | | | | | | | | | | | | | | | X | | | | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | | | | | | | | | | | | X | | | | | |
| Computer Integrated Manufacturing (CIM) | | | | | | | | | | | | | | | | | | | | | | | X | |
| Cybersecurity | | | | | | | | | | | | | X | | | | | | | | | | | X |
| Data Science and Analytics | | | | | | | | | | | | | | | | | | X | | X | X | | X | |
| Debating Technological Issues | | | | | | | | | | | | | | | | | | | | | | | | |
| Digital Video Production | | | | | | | | | | | | | | | | | | | | | | | | |
| Dragster Design | | | | | | | | | | | | | | | | | | | | | | | | |
| Engineering Design | | | | | | | | | | | | | | | | | | | X | X | X | X | X | X |
| Essays on Technology | | | | | | | | | | | | | | | | | | | | | | | | |
| Extemporaneous Speech | | | | | | | | | | | | | | | | | | | | | | | | |
| Fashion Design and Technology | | | | | | | | | | | | | | | | | | | | | | | | |
| Flight Endurance | | | | | | | | | | | | | | | | | | | | | | | | |
| Forensic Science | | | | | | | | | | | | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | | | | | | | | | | | | | | | | | | | | | | |
| Geospatial Technology | | | | | | | | | X | | | | | | | | | | | X | | | | |
| Music Production | | | | | | | | | | | | | | | | | | | | | | | | |
| On Demand Video | | | | | | | | | | | | | | | | | | | | | | | | |
| Photographic Technology | | | | | | | | | | | | | | | | | | | | | | | | |
| Prepared Presentation | | | | | | | | | | | | | | | | | | | | | | | | |
| Promotional Design | | | | | | | | | | | | | | | | | | | | | | | | |
| Scientific and Technical Visualization (SciVis) | | | | | | | | | | | | | | | | | | | | | | | | X |
| Software Development | | | | | | | | | | | | | | | | | | | | | | | | |
| Structural Design and Engineering | | | | | | | | | | | | | | | | | | | | | | X | X | |
| System Control Technology | | | | | | | | | | | | | | | | | | | | | | | | |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | | | | | | | | | | | | | | | | | | | |
| Transportation Modeling | | | | | | | | | | | | | | | | | | | X | | X | X | X | |
| Video Game Design | | | | | | | | | | | | | | | | | | | | | | | | |
| Webmaster | | | | | | | | | | | | | | | | | | | | | | | | |

## STANDARDS FOR TECHNOLOGICAL AND ENGINEERING LITERACY (STEL)

### STEL 1. Nature and Characteristics of Technology and Engineering

- **1N.** Explain how the world around them guides technological development and engineering design.
- **1O.** Assess how similarities and differences among scientific, mathematics, engineering, and technological knowledge and skills contributed to the design of a product or system.
- **1P.** Analyze the rate of technological development and predict future diffusion and adoption of new technologies.
- **1Q.** Conduct research to inform intentional inventions and innovations that address specific needs and wants.
- **1R.** Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system.

### STEL 2. Core Concepts of Technology and Engineering

- **2T.** Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.
- **2U.** Diagnose a flawed system embedded within a larger technological, social, or environmental system.
- **2V.** Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop.
- **2W.** Select resources that involve tradeoffs between competing values, such as availability, cost, desirability, and waste while solving problems.
- **2X.** Cite examples of the criteria and constraints of a product or system and how they affect final design.
- **2Y.** Implement quality control as a planned process to ensure that a product, service, or system meets established criteria.
- **2Z.** Use management processes in planning, organizing, and controlling work.

### STEL 3. Integration of Knowledge, Technologies, and Practices

- **3H.** Analyze how technology transfer occurs when a user applies an existing innovation developed for one function for a different purpose.
- **3I.** Evaluate how technology enhances opportunities for new products and services through globalization.
- **3J.** Connect technological progress to the advancement of other areas of knowledge and vice versa.

### STEL 4. Impacts of Technology

- **4P.** Evaluate ways that technology can impact individuals, society, and the environment.
- **4Q.** Critique whether existing or proposed technologies use resources sustainably.
- **4R.** Assess a technology that minimizes resource use and resulting waste to achieve a goal.
- **4S.** Develop a solution to a technological problem that has the least negative environmental and social impact.
- **4T.** Evaluate how technologies alter human health and capabilities.

### STEL 5. Influence of Society on Technological Development

- **5H.** Evaluate a technological innovation that arose from a specific society's unique need or want.
- **5I.** Evaluate a technological innovation that was met with societal resistance impacting its development.
- **5J.** Design an appropriate technology for use in a different culture.

### STEL 6. History of Technology

- **6F.** Relate how technological development has been evolutionary, often the result of a series of refinements to basic inventions or technological knowledge.
- **6G.** Verify that the evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools, materials, and processes.
- **6H.** Evaluate how technology has been a powerful force in reshaping the social, cultural, political, and economic landscapes throughout history.
- **6I.** Analyze how the Industrial Revolution resulted in the development of mass production, sophisticated transportation and communication systems, advanced construction practices, and improved education and leisure time.
- **6J.** Investigate the widespread changes that have resulted from the Information Age, which has placed emphasis on the processing and exchange of information.

### STEL 7. Design in Technology and Engineering Education

- **7W.** Determine the best approach by evaluating the purpose of the design.
- **7X.** Document trade-offs in the technology and engineering design process to produce the optimal design.
- **7Y.** Optimize a design by addressing desired qualities within criteria and constraints.
- **7Z.** Apply principles of human-centered design.
- **7AA.** Illustrate principles, elements, and factors of design.
- **7BB.** Implement the best possible solution to a design.
- **7CC.** Apply a broad range of design skills to their design process.
- **7DD.** Apply a broad range of making skills to their design process.

### STEL 8. Applying, Maintaining, and Assessing Technological Products and Systems

- **8N.** Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.
- **8O.** Develop a device or system for the marketplace.
- **8P.** Apply appropriate methods to diagnose, adjust and repair systems to ensure precise, safe and proper functionality.
- **8Q.** Synthesize data and analyze trends to make decisions about technological products, systems, or processes.
- **8R.** Interpret the results of technology assessment to guide policy development.

| STANDARDS FOR TECHNOLOGICAL AND ENGINEERING LITERACY (STEL) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Event | STEL Benchmark | 1N | 1O | 1P | 1Q | 1R | 2T | 2U | 2V | 2W | 2X | 2Y | 2Z | 3H | 3I | 3J | 4P | 4Q | 4R | 4S | 4T |
| Animatronics | | | | | X | X | X | | X | | X | X | X | | | | | | | | |
| Architectural Design | | X | | | | | X | | | | X | X | X | | | | | X | | X | |
| Biotechnology Design | | X | X | X | X | X | X | | X | | | | X | | | | X | | X | X | X |
| Board Game Design | | | | | | | X | | | | X | X | X | | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | X | | | | X | X | X | | | | | | | | |
| Coding | | | | | | X | X | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Architecture | | | | | | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | | | | | | | | | | | | | | |
| Computer Integrated Manufacturing (CIM) | | | | | X | X | X | | | X | X | X | X | | | | | | | | |
| Cybersecurity | | | | | | | | X | X | | | X | | | | | | | | | |
| Data Science and Analytics | | | X | X | X | X | X | | X | X | X | X | X | | | | | | | | |
| Debating Technological Issues | | | | | X | | | | | | | | | | | | | | | | |
| Digital Video Production | | | | | X | | X | | | | | X | X | | | | | | | | |
| Dragster Design | | | | | | | X | | X | X | X | X | X | | | | | | | | |
| Engineering Design | | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Essays on Technology | | | | | X | | | | | | | | | | | X | X | X | | | |
| Extemporaneous Speech | | X | | | X | | | | | | X | | | X | X | X | X | X | X | X | X |
| Fashion Design and Technology | | | | | | | X | | | X | X | X | X | | | | | | | | |
| Flight Endurance | | | | | | X | X | | X | X | | X | X | | | | | | | | |
| Forensic Science | | | | | | X | | X | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | | | X | X | | | | | | | X | | | | | | | | |
| Geospatial Technology | | | | X | X | X | X | X | X | X | X | X | X | | | | X | X | X | X | X |
| Music Production | | | | | | | X | | | | | | | | | | | | | | |
| On Demand Video | | | | | | | X | | | | | | | | | | | | | | |
| Photographic Technology | | | | | | | X | | | | | | | | | | | | | | |
| Prepared Presentation | | | | | | | X | | | | | | | | | | | | | | |
| Promotional Design | | | | | | | X | | | | | | | | | | | | | | |
| Scientific and Technical Visualization (SciVis) | | | X | | X | X | X | | | | | | X | | | | | | | | |
| Software Development | | | X | X | X | X | X | X | | | | | | | | | | | | | |
| Structural Design and Engineering | | | X | | X | X | X | | X | X | | X | X | | | | | | | | |
| System Control Technology | | | X | | X | X | X | | X | | X | X | X | | | | | | | | |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | X | X | | X | X | | X | X | | | | | | | | |
| Transportation Modeling | | | | | X | X | X | | | | X | X | X | | | | | | | | |
| Video Game Design | | | | | X | X | X | | | | X | X | X | | | | | | | | |
| Webmaster | | | X | | X | X | X | | X | | X | X | X | | | | | | | | |

| STANDARDS FOR TECHNOLOGICAL AND ENGINEERING LITERACY (STEL) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Event | STEL Benchmark | 5H | 5I | 5J | 6F | 6G | 6H | 6I | 6J | 7W | 7X | 7Y | 7Z | 7AA | 7BB | 7CC | 7DD | 8N | 8O | 8P | 8Q | 8R |
| Animatronics | | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | | |
| Architectural Design | | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| Biotechnology Design | | X | X | X | X | | | | | X | X | X | X | X | X | X | X | X | X | | X | |
| Board Game Design | | | | | | | | | | X | X | X | X | X | X | X | X | | X | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| Coding | | | | | | | | | | X | X | X | | X | X | X | X | | | X | X | |
| Computer-Aided Design (CAD), Architecture | | | | | | | | | | X | X | X | | X | X | X | | | | | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | | | X | X | X | | X | X | X | | | | | | |
| Computer Integrated Manufacturing (CIM) | | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | |
| Cybersecurity | | | | | | | | | | | | | | | | | | X | | X | X | |
| Data Science and Analytics | | | | | | | | | | X | X | X | X | X | X | X | X | X | | | X | |
| Debating Technological Issues | | | | | | | | | | | | | | | | | | | | | | |
| Digital Video Production | | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| Dragster Design | | | | | | | | | | X | X | X | X | X | X | X | X | | | X | | |
| Engineering Design | | X | X | X | X | X | X | | | X | X | X | X | X | X | X | X | X | | X | X | |
| Essays on Technology | | | | | | | | | | | | | | | | | | | | | X | |
| Extemporaneous Speech | | | | | | | X | | | | | | | | | | | X | | | X | |
| Fashion Design and Technology | | | | | | | | | | X | X | X | X | X | X | X | X | | X | | | |
| Flight Endurance | | | | | | | | | | X | X | X | X | X | X | X | X | | | X | X | |
| Forensic Science | | | | | | | | | | | | | | | | | | | | | X | |
| Future Technology and Engineering Teacher | | | | | X | | | | | X | X | X | X | X | X | X | X | X | | | X | |
| Geospatial Technology | | X | X | | X | X | X | | | | | | | | | | | X | | | X | X |
| Music Production | | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| On Demand Video | | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| Photographic Technology | | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| Prepared Presentation | | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| Promotional Design | | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| Scientific and Technical Visualization (SciVis) | | | | | | | | | | X | X | X | X | X | X | X | X | X | | | X | |
| Software Development | | X | X | | | | | | | X | X | X | X | X | X | X | X | X | | | X | |
| Structural Design and Engineering | | | | | | | | | | X | X | X | X | X | X | X | X | | | X | X | |
| System Control Technology | | | | | | | | | | X | X | X | X | X | X | X | X | X | | | X | |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | | | | | X | X | X | X | X | X | X | X | | | X | | |
| Transportation Modeling | | | | | | | | | | X | X | X | X | X | X | X | X | | | X | | |
| Video Game Design | | | | | | | | | | X | X | X | X | X | X | X | X | | | X | X | |
| Webmaster | | | | | | | | | | X | X | X | X | X | X | X | X | | | X | X | |

## AP COMPUTER SCIENCE STANDARDS

### A. Creative Development (CRD)

1. **CRD-1:** Incorporating multiple perspectives through collaboration improves computing innovations as they are developed.
    a. **CRD-1.A:** Explain how computing innovations are improved through collaboration.
    b. **CRD-1.B:** Explain how computing innovations are developed by groups of people.
    c. **CRD-1.C:** Demonstrate effective interpersonal skills during collaboration.
2. **CRD-2:** Developers create and innovate using an iterative design process that is user-focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.
    a. **CRD-2.A:** Describe the purpose of a computing innovation.
    b. **CRD-2.B:** Explain how a program or code segment functions.
    c. **CRD-2.C:** Identify input(s) to a program.
    d. **CRD-2.D:** Identify output(s) produced by a program.
    e. **CRD-2.E:** Develop a program using a development process.
    f. **CRD-2.F:** Design a program and its user interface.
    g. **CRD-2.G:** Describe the purpose of a code segment or program by writing documentation.
    h. **CRD-2.H:** Acknowledge code segments used from other sources.
    i. **CRD-2.I:** For errors in an algorithm or program:
        i. Identify the error.
        ii. Correct the error.
    j. **CRD-2.J:** Identify inputs and corresponding expected outputs or behaviors that can be used to check the correctness of an algorithm or program.

### B. Data (DAT)

1. **DAT-1:** The way a computer represents data internally is different from the way the data are interpreted and displayed for the user. Programs are used to translate data into a representation more easily understood by people.
    a. **DAT-1.A:** Explain how data can be represented using bits.
    b. **DAT-1.B:** Explain the consequences of using bits to represent data.
    c. **DAT-1.C:** For binary numbers:
        i. Calculate the binary (base 2) equivalent of a positive integer (base 10) and vice versa.
        ii. Compare and order binary numbers.
    d. **DAT-1.D:** Compare data compression algorithms to determine which is best in a particular context.
2. **DAT-2:** Programs can be used to process data, which allows users to discover information and create new knowledge.
    a. **DAT-2.A:** Describe what information can be extracted from data.
    b. **DAT-2.B:** Describe what information can be extracted from metadata.
    c. **DAT-2.C:** Identify the challenges associated with processing data.
    d. **DAT-2.D:** Extract information from data using a program.
    e. **DAT-2.E:** Explain how programs can be used to gain insight and knowledge from data.

### C. Algorithms and Programming (AAP)

1. **AAP-1:** To find specific solutions to generalizable problems, programmers represent and organize data in multiple ways.
    a. **AAP-1.A:** Represent a value with a variable.
    b. **AAP-1.B:** Determine the value of a variable as a result of an assignment.
    c. **AAP-1.C:** Represent a list or string using a variable.

d. **AAP-1.D:** For data abstraction:
    i. Develop data abstraction using lists to store multiple elements.
    ii. Explain how the use of data abstraction manages complexity in program code.

2. **AAP-2:** The way statements are sequenced and combined in a program determines the computed result. Programs incorporate iteration and selection constructs to represent repetition and make descisions to handle varied input values.
    a. **AAP-2.A:** Express an algorithm that uses sequencing without using a programming language.
    b. **AAP-2.B:** Represent a step-by-step algorithmic process using sequential code statements.
    c. **AAP-2.C:** Evaluate expressions that use arithmetic operators.
    d. **AAP-2.D:** Evaluate expressions that manipulate strings.
    e. **AAP-2.E:** For relationships between two variables, expressions, or values:
        i. Write expressions using relational operators.
        ii. Evaluate expressions that use relational operators.
    f. **AAP-2.F:** For relationships between Boolean values:
        i. Write expressions using logical operators.
        ii. Evaluate expressions that use logic operators.
    g. **AAP-2.G:** Express an algorithm that uses selection without using a programming language.
    h. **AAP-2.H:** For selection:
        i. Write conditional statements.
        ii. Determine the result of conditional statements.
    i. **AAP-2.I:** For nested selection:
        i. Write nested conditional statements.
        ii. Determine the result of nested conditional statements.
    j. **AAP-2.J: E**xpress an algorithm that uses iteration without using a programming language.
    k. **AAP-2.K:** For iteration:
        i. Write iteration statements.
        ii. Determine the result or side effect of iteration statements.
    l. **AAP-2.L:** Compare multiple algorithms to determine if they yield the same side effect or result.
    m. **AAP-2.M:** For algorithms:
        i. Create algorithms.
        ii. Combine and modify existing algorithms.
    n. **AAP-2.N:** For list operations:
        i. Write expressions that use list indexing and list procedures.
        ii. Evaluate expressions that use list indexing and list procedures.
    o. **AAP-2.O:** For algorithms involving elements of a list:
        i. Write iteration statements to traverse a list.
        ii. Determine the result of an algorithm that includes list traversals.
    p. **AAP-2.P:** For binary search algorithms:
        i. Determine the number of iterations required to find a value in a data set.
        ii. Explain the requirements necessary to complete a binary search.

3. **AAP-3:** Programmers break down problems into smaller and more manageable pieces. By creating procedures and leveraging parameters, programmers generalize processes that can be reused. Procedures allow programmers to draw upon existing code that has already been tested, allowing them to write programs more quickly and with more confidence.
    a. **AAP-3.A:** For procedure calls:
        i. Write statements to call procedures.
        ii. Determine the result or effect of a procedure call.

b. **AAP-3.B:** Explain how the use of procedural abstraction manages complexity in a program.
c. **AAP-3.C:** Develop procedural abstractions to manage complexity in a program by writing procedures.
d. **AAP-3.D:** Select appropriate libraries or existing code segments to use in creating new programs.
e. **AAP-3.E:** For generating random values:
    i. Write expressions to generate possible values.
    ii. Evaluate expressions to determine the possible results.
f. **AAP-3.F:** For simulations:
    i. Explain how computers can be used to represent real-world phenomena or outcomes.
    ii. Compare simulations with real-world contexts.

4. **AAP-4:** There exist problems that computers cannot solve, and even when a computer can solve a problem, it may not be able to do so in a reasonable amount of time.
    a. **AAP-4.A:** For determining the efficiency of an algorithm:
        i. Explain the difference between algorithms that run in reasonable time and those that do not.
        ii. Identify situations where a heuristic solution may be more appropriate.
    b. **AAP-4.B:** Explain the existence of undecidable problems in computer science.

## D. Computer Systems and Networks (CSN)

1. **CSN-1:** Computer systems and networks facilitate the transfer of data.
    a. **CSN-1.A:** Explain how computing devices work together in a network.
    b. **CSN-1.B:** Explain how the Internet works.
    c. **CSN-1.C**: Explain how data are sent through the Internet via packets.
    d. **CSN-1.D:** Describe the differences between the Internet and the World Wide Web.
    e. **CSN-1.E:** For fault-tolerant systems, like the Internet:
        i. Describe the benefits of fault tolerance.
        ii. Explain how a given system is fault-tolerant.
        iii. Identify vulnerabilities to failure in a system.
2. **CSN-2:** Parallel and distributed computing leverage multiple computers to more quickly solve complex problems or process large data sets.
    a. **CSN-2.A:** For sequential, parallel, and distributed computing:
        i. a. Compare problem solutions.
        ii. b. Determine the efficiency of solutions.
    b. **CSN-2.B:** Describe benefits and challenges of parallel and distributed computing.

## E. Impact of Computing (IOC)

1. **IOC-1:** While computing innovaions are typically designed to achieve a specific purpose, they may have unintended consequences.
    a. **IOC-1.A:** Explain how an effect of a computing innovation can be both beneficial and harmful.
    b. **IOC-1.B:** Explain how a computing innovation can have an impact beyond its intended purpose.
    c. **IOC-1.C:** Describe issues that contribute to the digital divide.
    d. **IOC-1.D:** Explain how bias exists in computing innovations.
    e. **IOC-1.E:** Explain how people participate in problem solving processes at scale.
    f. **IOC-1.F:** Explain how the use of computing can raise legal and ethical concerns.
2. **IOC-2:** The use of computing innovations may involve risks to personal safety and identity.
    a. **IOC-2.A:** Describe the risks to privacy from collecting and storing personal data on a computer system.

## AP COMPUTER SCIENCE STANDARDS

| Event | Standard Number | CRD-1.A | CRD-1.B | CRD-1.C | CRD-2.A | CRD-2.B | CRD-2.C | CRD-2.D | CRD-2.E | CRD-2.G | CRD-2.H | CRD-2.I | CRD-2.J | DAT-1.A | DAT-1.B | DAT-1.C | DAT-1.D | DAT-2.A | DAT-2.B | DAT-2.C | DAT-2.D | DAT-2.E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Animatronics | | X | | X | | X | X | X | X | X | | X | | | | | | | | | | |
| Architectural Design | | | | | | | | | | | | | | | | | | | | | | |
| Biotechnology Design | | | | | | | | | | | | | | | | | | | | | | |
| Board Game Design | | | | | | | | | | | | | | | | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | | | | | | | | | | | | | |
| Coding | | | | | | X | X | X | | X | X | X | X | X | X | X | X | | | | | |
| Computer-Aided Design (CAD), Architecture | | | | | | | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | | | | | | | | | | | | | | | |
| Computer Integrated Manufacturing (CIM) | | X | | X | X | | X | X | | | | | | | | | | | | | | |
| Cybersecurity | | | | X | | | X | | | | X | X | X | | | | | X | X | X | | |
| Data Science and Analytics | | | | | | | | | | | | | | | | | | X | X | X | X | X |
| Debating Technological Issues | | | | | | | | | | | | | | | | | | | | | | |
| Digital Video Production | | | | | | | | | | | | | | | | | | | | | | |
| Dragster Design | | | | | | | | | | | | | | | | | | | | | | |
| Engineering Design | | | | | | | | | | | | | | | | | | | | | | |
| Essays on Technology | | | | | | | | | | | | | | | | | | | | | | |
| Extemporaneous Speech | | | | | | | | | | | | | | | | | | | | | | |
| Fashion Design and Technology | | | | | | | | | | | | | | | | | | | | | | |
| Flight Endurance | | | | | | | | | | | | | | | | | | | | | | |
| Forensic Science | | | | | | | | | | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | | | | | | | | | | | | | | | | | | | | |
| Geospatial Technology | | | | | | | | | | | | | | | | | | X | X | X | X | X |
| Music Production | | | | | | | | | | | | | | | | | | | | | | |
| On Demand Video | | | | | | | | | | | | | | | | | | | | | | |
| Photographic Technology | | | | | | | | | | | | | | | | | | | | | | |
| Prepared Presentation | | | | | | | | | | | | | | | | | | | | | | |
| Promotional Design | | | | | | | | | | | | | | | | | | | | | | |
| Scientific and Technical Visualization (SciVis) | | X | | X | | | | | | | | | | | | | | | | | | |
| Software Development | | X | | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | |
| Structural Design and Engineering | | | | | | | | | | | | | | | | | | | | | | |
| System Control Technology | | X | | X | X | X | X | X | X | X | X | X | X | | | | | | | | | |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | | | | | | | | | | | | | | | | | |
| Transportation Modeling | | | | | | | | | | | | | | | | | | | | | | |
| Video Game Design | | X | | X | | | X | X | X | X | X | X | X | | | | | | | | | |
| Webmaster | | | | | | | X | X | X | | X | X | | | | | | | | | | |

## AP COMPUTER SCIENCE STANDARDS – continued

| Event | Standard Number | AAP-1.A | AAP-1.B | AAP-1.C | AAP-1.D | AAP-2.A | AAP-2.B | AAP-2.C | AAP-2.D | AAP-2.E | AAP-2.F | AAP-2.G | AAP-2.H | AAP-2.I | AAP-2.J | AAP-2.K | AAP-2.L | AAP-2.M | AAP-2.N | AAP-2.O | AAP-2.P | AAP-3.A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Animatronics | | | | X | | | X | X | X | X | | | X | X | | | | | X | X | | X |
| Architectural Design | | | | | | | | | | | | | | | | | | | | | | |
| Biotechnology Design | | | | | | | | | | | | | | | | | | | | | | |
| Board Game Design | | | | | | | | | | | | | | | | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | | | | | | | | | | | | | |
| Coding | | X | X | X | X | | X | X | X | X | X | | X | X | | X | X | | | | | |
| Computer-Aided Design (CAD), Architecture | | | | | | | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | | | | | | | | | | | | | | | |
| Computer Integrated Manufacturing (CIM) | | | | | | | | | | | | | | | | | | | | | | |
| Cybersecurity | | | | | | | | | | | | | | | | | | | | | | |
| Data Science and Analytics | | | | | | | | | | | | | | | | | | | | | | |
| Debating Technological Issues | | | | | | | | | | | | | | | | | | | | | | |
| Digital Video Production | | | | | | | | | | | | | | | | | | | | | | |
| Dragster Design | | | | | | | | | | | | | | | | | | | | | | |
| Engineering Design | | | | | | | | | | | | | | | | | | | | | | |
| Essays on Technology | | | | | | | | | | | | | | | | | | | | | | |
| Extemporaneous Speech | | | | | | | | | | | | | | | | | | | | | | |
| Fashion Design and Technology | | | | | | | | | | | | | | | | | | | | | | |
| Flight Endurance | | | | | | | | | | | | | | | | | | | | | | |
| Forensic Science | | | | | | | | | | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | | | | | | | | | | | | | | | | | | | | |
| Geospatial Technology | | | | | | | | | | | | | | | | | | | | | | |
| Music Production | | | | | | | | | | | | | | | | | | | | | | |
| On Demand Video | | | | | | | | | | | | | | | | | | | | | | |
| Photographic Technology | | | | | | | | | | | | | | | | | | | | | | |
| Prepared Presentation | | | | | | | | | | | | | | | | | | | | | | |
| Promotional Design | | | | | | | | | | | | | | | | | | | | | | |
| Scientific and Technical Visualization (SciVis) | | | | X | | | X | X | X | X | | | X | X | | | | | | | | X |
| Software Development | | X | X | X | X | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | | X |
| Structural Design and Engineering | | | | | | | | | | | | | | | | | | | | | | |
| System Control Technology | | | | | | | X | X | X | | X | | X | X | | X | X | X | X | X | | X |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | | | | | | | | | | | | | | | | | |
| Transportation Modeling | | | | | | | | | | | | | | | | | | | | | | |
| Video Game Design | | X | X | X | | | X | X | X | X | X | | X | X | | X | X | X | X | X | | X |
| Webmaster | | | | X | | | X | X | X | | | | X | X | | | | | X | | | X |

## AP COMPUTER SCIENCE STANDARDS – continued

| Event | Standard Number | AAP-3.B | AAP-3.C | AAP-3.D | AAP-3.E | AAP-3.F | AAP-4.A | AAP-4.B | CSN-1.A | CSN-1.B | CSN-1.C | CSN-1.D | CSN-1.E | CSN-2.A | CSN-2.B | IOC-1.A | IOC-1.B | IOC-1.C | IOC-1.D | IOC-1.E | IOC-1.F | IOC-2.A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Animatronics | | X | X | X | | | | | | | | | | | | | | | | | | |
| Architectural Design | | | | | | | | | | | | | | | | | | | | | | |
| Biotechnology Design | | | | | | | | | | | | | | | | | | | | | | |
| Board Game Design | | | | | | | | | | | | | | | | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | | | | | | | | | | | | | |
| Coding | | | | | | | X | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Architecture | | | | | | | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | | | | | | | | | | | | | | | |
| Computer Integrated Manufacturing (CIM) | | | | | | | | | | | | | | | | | | | | | | |
| Cybersecurity | | | | | | X | | | X | X | X | X | X | | | | | | | | X | X |
| Data Science and Analytics | | | | | | | | | | | | | | | | | | | | | | |
| Debating Technological Issues | | | | | | | | | | | | | | | | | | | | | | |
| Digital Video Production | | | | | | | | | | | | | | | | | | | | | | |
| Dragster Design | | | | | | | | | | | | | | | | | | | | | | |
| Engineering Design | | | | | | | | | | | | | | | | | | | | | | |
| Essays on Technology | | | | | | | | | | | | | | | | | | | | | | |
| Extemporaneous Speech | | | | | | | | | | | | | | | | | | | | | | |
| Fashion Design and Technology | | | | | | | | | | | | | | | | | | | | | | |
| Flight Endurance | | | | | | | | | | | | | | | | | | | | | | |
| Forensic Science | | | | | | | | | | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | | | | | | | | | | | | | | | | | | | | |
| Geospatial Technology | | | | | | | | | | | | | | | | | | | | | | |
| Music Production | | | | | | | | | | | | | | | | | | | | | | |
| On Demand Video | | | | | | | | | | | | | | | | | | | | | | |
| Photographic Technology | | | | | | | | | | | | | | | | | | | | | | |
| Prepared Presentation | | | | | | | | | | | | | | | | | | | | | | |
| Promotional Design | | | | | | | | | | | | | | | | | | | | | | |
| Scientific and Technical Visualization (SciVis) | | X | X | X | | X | | | | | | | | | | | | | | | | |
| Software Development | | X | X | X | X | | X | | | | | | | | | X | | | | | | |
| Structural Design and Engineering | | | | | | | | | | | | | | | | | | | | | | |
| System Control Technology | | X | X | X | | | X | | | | | | | | | X | X | | | | | |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | | | | | | | | | | | | | | | | | |
| Transportation Modeling | | | | | | | | | | | | | | | | | | | | | | |
| Video Game Design | | X | X | X | X | X | X | | | | | | | | | | | | | | | |
| Webmaster | | X | | X | | | | | | | | | | | | | | | | | | |

## AP COMPUTER SCIENCE: COMPUTATIONAL THINKING PRACTICES

### Practice 1: Computational Solution Design

Design and evaluate computational solutions for a purpose.

A. Investigate the situation, context, or task.
B. Determine and design an appropriate method or approach to achieve the purpose.
C. Explain how collaboration affects the development of a solution.
D. Evaluate solution options.

### Practice 2: Algorithms and Program Development

Develop and implement algorithms.

A. Represent algorithmic processes without using a programming language.
B. Implement and apply an algorithm.

### Practice 3: Abstraction in Program Development

Develop programs that incorporate abstractions.

A. Generalize data sources through variables.
B. Use abstraction to manage complexity in a program.
C. Explain how abstraction manages complexity.

### Practice 4: Code Analysis

Evaluate and test algorithms and programs.

A. Explain how a code segment or program functions.
B. Determine the result of code segments.
C. Identify and correct errors in algorithms and programs, including error discovery through testing.

### Practice 5: Computing Innovations

Investigate computing innovations.

A. Explain how computing systems work.
B. Explain how knowledge can be generated from data.
C. Describe the impact of a computing innovation.
D. Describe the impact of gathering data.
E. Evaluate the use of computing based on legal and ethical factors.

### Practice 6: Responsible Computing

Contribute to an inclusive, safe, collaborative, and ethical computing culture.

A. Collaborate in the development of solutions.
B. Use safe and secure methods when using computing devices.
C. Acknowledge the intellectual property of others.

## AP COMPUTER SCIENCE: COMPUTATIONAL THINKING PRACTICES

| Event / Standard Number | 1A | 1B | 1C | 1D | 2A | 2B | 3A | 3B | 3C | 4A | 4B | 4C | 5A | 5B | 5C | 5D | 5E | 6A | 6B | 6C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Animatronics | | X | X | | | | | X | | | | X | | | | | | X | | |
| Architectural Design | X | X | | X | | | | | | | | | | | | | | | | |
| Biotechnology Design | X | X | | X | | | | | | | | | | | X | | | | | |
| Board Game Design | | | | | | | | | | | | | | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | | | | | | | | | | | |
| Coding | | | | | | X | | X | X | X | X | X | X | X | | | | X | | |
| Computer-Aided Design (CAD), Architecture | X | X | | X | | | | | | | | | | | | | | | | |
| Computer-Aided Design (CAD), Engineering | X | X | | X | | | | | | | | | | | | | | | | |
| Computer Integrated Manufacturing (CIM) | | | | | | | | | | | | | | | | | | | | |
| Cybersecurity | | | X | X | | | | | | | X | X | | | | | X | X | X | X |
| Data Science and Analytics | X | X | X | X | X | | X | | | | | | | X | | X | X | | | X |
| Debating Technological Issues | | | | | | | | | | | | | | | | | | | | |
| Digital Video Production | | | | | | | | | | | | | | | | | | | | |
| Dragster Design | | | | | | | | | | | | | | | | | | | | |
| Engineering Design | | | | | | | | | | | | | | | | | | | | |
| Essays on Technology | | | | | | | | | | | | | | | | | | | | |
| Extemporaneous Speech | | | | | | | | | | | | | | | | | | | | |
| Fashion Design and Technology | | | | | | | | | | | | | | | | | | | | |
| Flight Endurance | | | | | | | | | | | | | | | | | | | | |
| Forensic Science | | | | | | | | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | | | | | | | | | | | | | | | | | | |
| Geospatial Technology | X | | X | | | | | | | | | | | X | | X | X | X | | X |
| Music Production | | | | | | | | | | | | | | | | | | | | |
| On Demand Video | | | | | | | | | | | | | | | | | | | | |
| Photographic Technology | | | | | | | | | | | | | | | | | | | | |
| Prepared Presentation | | | | | | | | | | | | | | | | | | | | |
| Promotional Design | X | X | | X | | | | | | | | | | | | | | | | X |
| Scientific and Technical Visualization (SciVis) | X | X | X | X | | | | X | | | | X | | | | | | X | | X |
| Software Development | X | X | X | X | | X | | X | X | | | X | X | X | X | | X | X | X | X |
| Structural Design and Engineering | | | | | | | | | | | | | | | | | | | | |
| System Control Technology | X | X | X | X | | X | | | | | | X | | X | X | | X | X | X | X |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | | | | | | | | | | | | | | | |
| Transportation Modeling | | | | | | | | | | | | | | | | | | | | |
| Video Game Design | | X | X | X | | | | X | | | | X | | | | | | | | X |
| Webmaster | | X | X | X | | | | X | | | | X | | | | | | X | | X |

## ISTE STANDARDS FOR STUDENTS – 2016 INTERNATIONAL SOCIETY FOR TECHNOLOGY IN EDUCATION

1. Empowered Learner
   Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.
   a. articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes
   b. build networks and customize their learning environments in ways that support the learning process
   c. use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways
   d. understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies
2. Digital Citizen
   Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
   a. cultivate and manage their digital identity and reputation and are aware of the permanence of their actions in the digital world
   b. engage in positive, safe, legal and ethical behavior when using technology, including social interactions online or when using networked devices
   c. demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property
   d. manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online
3. Knowledge Constructor
   Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.
   a. plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits
   b. evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources
   c. curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions
   d. build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions
4. Innovative Designer
   Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.
   a. know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems
   b. select and use digital tools to plan and manage a design process that considers design constraints and calculated risks
   c. develop, test and refine prototypes as part of a cyclical design process
   d. exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems
   e. Computational Thinker
   Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.

a. formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions

b. collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making

c. break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving

d. understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions

6. Creative Communicator
Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.

a. choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication

b. create original works or responsibly repurpose or remix digital resources into new creations

c. communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations

d. publish or present content that customizes the message and medium for their intended audiences

7. Global Collaborator
Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.

a. use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways that broaden mutual understanding and learning

b. use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints

c. contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal

d. explore local and global issues and use collaborative technologies to work with others to investigate solutions

| ISTE STANDARDS FOR STUDENTS | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Event | Standard Number | 1a | 1b | 1c | 1d | 2a | 2b | 2c | 2d | 3a | 3b | 3c | 3d | 4a | 4b | 4c | 4d | 5a | 5b | 5c | 5d | 6a | 6b | 6c | 6d | 7a | 7b | 7c | 7d |
| Animatronics | | X | | | X | | | | | | | | | X | X | X | X | | | | X | X | X | X | X | | | X | |
| Architectural Design | | X | X | X | | | | | | X | X | X | X | X | X | X | X | | | | | X | X | X | X | | | X | X |
| Biotechnology Design | | X | | | | | | | | X | X | X | X | X | | | X | X | X | | | X | X | X | X | | | X | X |
| Board Game Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coding | | | | | X | | | | | | | | | | | | | | | X | | | | | | | X | |
| Computer-Aided Design (CAD), Architecture | | | | | | | | | | | | | | X | X | X | X | | | | | X | X | X | X | | | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | | | | | | | X | X | X | X | | | | | X | X | X | X | | | | |
| Computer Integrated Manufacturing (CIM) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cybersecurity | | X | X | | X | X | X | X | | | | | | | | | | | | | | | | | | | | X | |
| Data Science and Analytics | | X | | | | | | | | X | X | X | X | | | | | X | X | X | | X | X | X | X | | | X | X |
| Debating Technological Issues | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Digital Video Production | | X | X | | X | | | | | X | | X | | X | | | X | | | | | X | X | X | X | X | X | X | X |
| Dragster Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Engineering Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Essays on Technology | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extemporaneous Speech | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fashion Design and Technology | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Flight Endurance | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Forensic Science | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Geospatial Technology | | X | | | | | | | | X | X | X | X | X | | | X | | X | X | | X | X | X | X | | | X | X |
| Music Production | | X | | | X | | | | | X | | X | | X | | | X | | | | | X | X | X | X | | | X | |
| On Demand Video | | X | | | X | | | | | X | | X | | X | | | X | | | | | X | X | X | X | | | X | |
| Photographic Technology | | X | | | X | | | | | X | | X | | X | | | X | | | | | X | X | X | X | | | X | X |
| Prepared Presentation | | X | | | | | | | | X | X | X | X | X | | | X | | | | | X | X | X | X | | | X | X |
| Promotional Design | | X | | | X | | | | | X | | X | | X | | | X | | | | | X | X | X | X | | | X | X |
| Scientific and Technical Visualization (SciVis) | | X | | | X | | | | | X | | X | | X | | | X | | | | | X | X | X | X | | | X | X |
| Software Development | | X | | | X | | | | | X | X | X | X | X | X | X | X | X | | | | X | X | X | X | | | X | X |
| Structural Design and Engineering | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| System Control Technology | | X | | | X | | | | | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X | | | X | X |
| Technology Bowl | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Technology Problem Solving | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transportation Modeling | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Video Game Design | | X | | | X | | | | | X | | X | | X | | | X | | | | | X | X | X | X | | | X | |
| Webmaster | | X | | | X | | | | | X | | X | | X | | | X | | | | | X | X | X | X | | | X | |

## CRITERIA FOR ACCREDITING ENGINEERING PROGRAMS (Accreditation Board for Engineering and Technology [ABET, Inc.])

Engineering programs must have documented student outcomes that prepare graduates to attain the program educational objectives.

Student outcomes are outcomes (A) through (K) plus any additional outcomes that may be articulated by the program.

A. An ability to apply knowledge of mathematics, science and engineering
B. An ability to design and conduct experiments, as well as to analyze and interpret data
C. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
D. An ability to function on multidisciplinary teams
E. An ability to identify, formulate and solve engineering problems
F. An understanding of professional and ethical responsibility
G. An ability to communicate effectively
H. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and social context
I. A recognition of the need for, and an ability to engage in life-long learning
J. A knowledge of contemporary issues
K. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

The outcomes listed are found in the *2016-2017 Criteria for Accrediting Engineering Programs* and used with permission from the Engineering Accreditation Commission of ABET, Inc.

Access the *2018-2019 Criteria for Accrediting Engineering Programs* for the latest outcomes.

(The outcomes were designed for higher education engineering programs, but they are relevant for middle school and high school level engineering-related courses.)

## CRITERIA FOR ACCREDITING ENGINEERING PROGRAMS (ABET, INC.)

| Standard | Event / Standard Letter | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A. An ability to apply knowledge of mathematics, science and engineering<br>B. An ability to design and conduct experiments, as well as to interpret data<br>C. An ability to design a system, component, or process to meet desired needs<br>D. An ability to function on multi-disciplinary teams<br>E. An ability to identify, formulate and solve engineering problems<br>F. An understanding of professional and ethical responsibility<br>G. An ability to communicate effectively<br>H. The broad education necessary to understand the impact of engineering in global and social contexts<br>I. A recognition of the need for and an ability to engage in life-long learning<br>J. A knowledge of contemporary issues<br>K. An ability to use the techniques, skills and modern engineering tools necessary for engineering practice. | Animatronics | X | | | X | X | | | | | | X |
| | Architectural Design | X | | X | X | X | X | X | X | X | X | X |
| | Biotechnology Design | X | X | X | X | X | X | X | X | X | X | X |
| | Board Game Design | X | | X | | X | | X | | X | X | X |
| | Chapter Team | | | | | | | | X | X | | |
| | Children's Stories | | | X | X | | X | X | | X | | |
| | Coding | X | | X | X | | | X | | | | X |
| | Computer-Aided Design (CAD), Architecture | X | | | | X | | X | X | X | X | X |
| | Computer-Aided Design (CAD), Engineering | X | | | | X | | X | X | X | X | X |
| | Computer Integrated Manufacturing (CIM) | X | X | X | X | X | X | X | X | X | X | X |
| | Cybersecurity | | | | X | | X | | | | X | |
| | Data Science and Analytics | X | X | | | | X | X | X | | X | |
| | Debating Technological Issues | | | | | | X | X | X | | | |
| | Digital Video Production | | | | | | X | X | | X | | |
| | Dragster Design | X | X | X | | X | X | X | | | | X |
| | Engineering Design | X | X | X | X | X | X | X | X | X | X | X |
| | Essays on Technology | X | X | | | | X | | | | X | |
| | Extemporaneous Speech | | | | | | X | X | X | | | |
| | Fashion Design and Technology | | | | X | X | | | X | | | |
| | Flight Endurance | X | X | X | | X | X | X | | X | | X |
| | Forensic Science | X | X | | | | | X | | | X | |
| | Future Technology and Engineering Teacher | X | | X | | | X | X | | | X | |
| | Geospatial Technology | | X | X | X | | X | X | | | X | |
| | Music Production | | | | | | | X | | | | |
| | On Demand Video | | | | X | | X | X | | | | |
| | Photographic Technology | X | | | | | X | X | | X | X | X |
| | Prepared Presentation | | | | | | | X | X | X | | |
| | Promotional Design | X | | | | | X | X | | | | |
| | Scientific and Technical Visualization (SciVis) | | X | | X | | | | | | | X |
| | Software Development | X | X | X | X | X | X | X | X | X | X | X |
| | Structural Design and Engineering | X | X | X | X | X | X | X | X | X | X | X |
| | System Control Technology | X | X | X | X | X | X | X | X | X | X | X |
| | Technology Bowl | X | X | X | | X | | | X | | X | X |
| | Technology Problem Solving | X | | X | | | | | | | | |
| | Transportation Modeling | X | X | X | | X | X | X | | | | X |
| | Video Game Design | | | X | X | | X | X | | X | | |
| | Webmaster | | | X | X | | | X | | | | |

## NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS (NCTM) PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

A. **Numbers and operations**
   1. Understand numbers, ways of representing numbers, relationships among numbers and number systems
   2. Understand meanings of operations and how they relate to one another
   3. Compute fluently and make reasonable estimates

B. **Algebra**
   1. Understand patterns, relations, and functions
   2. Represent and analyze mathematical situations and structures using algebraic symbols
   3. Use mathematical models to represent and understand quantitative relationships
   4. Analyze change in various contexts

C. **Geometry**
   1. Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships
   2. Specify locations and describe spatial relationships using coordinate geometry and other representational systems
   3. Apply transformations and use symmetry to analyze mathematical situations
   4. Use visualization, spatial reasoning and geometric modeling to solve problems

D. **Measurement**
   1. Understand measurable attributes of objects and the units, systems and processes of measurement
   2. Apply appropriate techniques, tools and formulas to determine measurements

E. **Data analysis and probability**
   1. Formulate questions that can be addressed with data and collect, organize and display relevant data to answer them
   2. Select and use appropriate statistical methods to analyze data
   3. Develop and evaluate inferences and predictions that are based on data
   4. Understand and apply basic concepts of probability

F. **Problem solving**
   1. Build new mathematical knowledge through problem solving
   2. Solve problems that arise in mathematics and in other contexts
   3. Apply and adapt a variety of appropriate strategies to solve problems
   4. Monitor and reflect on the process of mathematical problem solving

G. **Reasoning and proof**
   1. Recognize reasoning and proof as fundamental aspects of mathematics
   2. Make and investigate mathematical conjectures
   3. Develop and evaluate mathematical arguments and proofs
   4. Select and use various types of reasoning and methods of proof

H. **Communication**
   1. Organize and consolidate mathematical thinking through communication
   2. Communicate mathematical thinking coherently and clearly to peers, teachers and others
   3. Analyze and evaluate the mathematical thinking and strategies of others
   4. Use the language of mathematics to express mathematical ideas precisely

I. Connections
   1. Recognize and use connections among mathematical ideas
   2. Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
   3. Recognize and apply mathematics in contexts outside of mathematics

J. Representation
   1. Create and use representations to organize, record, and communicate mathematical ideas
   2. Select, apply, and translate among mathematical representations to solve problems
   3. Use representations to model and interpret physical, social and mathematical phenomena

## PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

| Event / Standard Number | A1 | A2 | A3 | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 | D1 | D2 | E1 | E2 | E3 | E4 | F1 | F2 | F3 | F4 | G1 | G2 | G3 | G4 | H1 | H2 | H3 | H4 | I1 | I2 | I3 | J1 | J2 | J3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Animatronics | | | | | | | | | | | | X | X | | | | | | X | X | | | | | | | | | | | X | | | |
| Architectural Design | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | X | X | X | X | | | | | | |
| Biotechnology Design | X | X | X | X | X | X | X | | | | | X | X | X | X | X | X | X | X | X | X | | | | | X | X | X | | | | | | | |
| Board Game Design | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | X | X | X | | | | | | | |
| Chapter Team | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Children's Stories | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coding | X | X | | | | | | | | | | | | | | | | X | | X | | | | | X | | | | | | | X | | X | X |
| Computer-Aided Design (CAD), Architecture | | | | | | | | X | X | | X | X | X | | | | | | | | | | | | | | | | | | | | X | | |
| Computer-Aided Design (CAD), Engineering | | | | | | | | X | X | | X | X | X | | | | | | | | | | | | | | | | | | | | X | | |
| Computer Integrated Manufacturing (CIM) | | | | | | | | X | X | X | X | X | X | | | | | X | X | X | X | | | | | | | | | | | | | | |
| Cybersecurity | | X | X | | | | | | | | | | | | | | | | X | X | | | X | | | | | | | X | | X | | X | X |
| Data Science and Analytics | | | | | | | | | | | | | | X | X | X | X | | | X | X | X | | | | X | X | X | X | X | X | X | X | X | X |
| Debating Technological Issues | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X |
| Digital Video Production | | | X | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | X | | | |
| Dragster Design | | | X | | | | X | X | X | | X | X | | | | | | | X | X | | | | | | | | | | X | X | | X | X |
| Engineering Design | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Essays on Technology | | | X | | | | | | | | | | | X | X | X | X | | | | | | | | | | | | | | | | | | |
| Extemporaneous Speech | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fashion Design and Technology | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | |
| Flight Endurance | | X | X | X | | | | X | | | X | X | X | | | X | X | X | X | X | X | | | X | | X | X | X | | | | X | | | |
| Forensic Science | | | | | | | | | | | | | | X | | X | | | | X | | | | | | | | | | | | | | | |
| Future Technology and Engineering Teacher | | | X | | | | | | | | | | | | | | | | X | X | | | | | X | | | | | | | X | | X | |
| Geospatial Technology | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Music Production | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | |
| On Demand Video | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | X | | | |
| Photographic Technology | | | | | | | | | | | | | | | | | | | | X | | | | | | X | | X | | | | | | | |
| Prepared Presentation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | X | | | |
| Promotional Design | | | | | | | | | | | X | | X | | | | | | | X | | | | | | | | | | | | | | | |
| Scientific and Technical Visualization (SciVis) | X | X | X | X | | | X | | | | X | | | | | | | | X | X | | | | | X | | | X | X | | X | | | | X |
| Software Development | | | | | | | | | | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | |
| Structural Design and Engineering | | X | X | X | X | X | | X | X | X | X | X | X | | | | X | | | X | X | | | | | X | X | X | X | | X | | X | X | |
| System Control Technology | X | X | X | X | X | X | | X | X | X | X | | | | | X | X | X | X | X | X | | X | X | X | X | X | | | X | X | X | | | |
| Technology Bowl | | | | | | | | X | X | | X | X | X | | | | | | X | X | | | | | | | | | X | | X | X | | | |
| Technology Problem Solving | | | | | | | | | | | | X | X | | | | | | X | X | | | | | | | | | | | | | | | |
| Transportation Modeling | | | | | | X | X | | X | | | X | X | | | | | | X | X | | | | | | | | | | X | | X | | | X |
| Video Game Design | | X | | | | | | | | | X | X | X | | | | | | | | | | | | | | | | | | | | | | |
| Webmaster | | | | | | | | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | |