HS-ETS-ETSS Links Among Engineering, Technology, Science, and Society

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Students who demonstrate understanding can:

a. **Plan and carry out an investigation to improve a technology and suggest ideas for further related scientific study.** [Clarification Statement: For example, a group of students investigate the environmental conditions needed to maintain a healthy aquatic population, apply findings to improving an aquarium, and recommend research that can be done with the improved technology to study aquatic ecosystems.]

b. **Gather evidence to evaluate different explanations for the widespread adoption of a modern technology, including the role of societal demands, market forces, evaluations by scientists and engineers, and possible government regulation.** [Clarification Statement: For example, students evaluate explanations for the rapid spread of cell phones, LED lighting, or genetically engineered crops for farming.)

c. **Analyze data to compare different technologies designed to accomplish the same function regarding their relative environmental impacts, costs, risks, and benefits, and what may need to be done to reduce unanticipated negative effects.** [Clarification Statement: Comparisons include paper vs. electronic books, nuclear vs. coal-fired power plants.] [Assessment Boundary: Analysis limited to data available online or provided to students.]

d. **Construct or critique arguments based on evidence concerning the costs, risks, and benefits of changes in major technological systems related to agriculture, health, water, energy, transportation, manufacturing, or construction, needed to support a growing world population.** [Clarification Statement: For example, students construct arguments concerning the costs and benefits of shifting from centralized to distributed energy generation systems or natural to genetically engineered crops.] [Assessment Boundary: Limited to relative comparison of costs and benefits of different technological changes.]

The performance expectations above were developed using the following elements from the NRC *A Framework for K – 12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that build, test, and revise conceptual, mathematical, physical and empirical models.

- Plan and carry out investigations Individually and collaboratively and test designs as part of building and revising models, explaining phenomena, or testing solutions to problems. Consider possible confounding variables or effects, and ensure the investigation's design has controlled for them. (a)

Analyzing and Interpreting Data
Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution. (c)

Engaging in Argument from Evidence
Engaging in argument from evidence in 9–12 builds from K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world. Arguments may also come from current scientific or historical episodes in science.

- Construct a counter-argument that is based in data and evidence that challenges another proposed argument (d)
- Criticize and evaluate arguments and design solutions in light of new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. (d)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluate the validity and reliability of the claims, methods, and designs.

- Critically read scientific literature adapted for classroom use to identify key ideas and major points and to evaluate the validity and reliability of the claims, methods, and designs. (b)
- Generate, synthesize, communicate, and critique claims, methods, and designs that appear in scientific and technical texts or media reports. (b)

Disciplinary Core Ideas

ETS2.A: Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). (a)
- Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (a)

ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

- Modern civilization depends on major technological systems, including those related to agriculture, health, water, energy, transportation, manufacturing, construction, and communications. (d)
- Engineers continuously modify these technological systems by applying scientific and engineering knowledge and practices to increase benefits while decreasing costs and risks. (d)
- Widespread adoption of technological innovations often depends on market forces or other societal demands, but it may also be subject to evaluation by scientists and engineers and to eventual government regulation. (b)
- New technologies can have deep impacts on society and the environment, including some that were not anticipated or that may build up over time to a level that requires attention or mitigation. (c)
- Analysis of costs, environmental impacts, risks and benefits, are critical aspects of decisions about technology use. (c)

Crosscutting Concepts

Cause and Effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects. (a),(b)

Stability and Change
Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. (b),(c),(d)

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HS-ETS-ETSS Links Among Engineering, Technology, Science, and Society *(continued)*

Connections to other DCIs in this grade-level: **HS.ESS-CC, HS.ESS-HS, HS.LS.IRE, HS.LS.NSE, HS.PS-ER, HS.PS-NP, HS.ETS-ED**

Articulation to DCIs across grade-levels: **MS.ETS-ETSS**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA –

W.8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
WHST.9	Draw evidence from informational texts to support analysis, reflection, and research.

Mathematics –

MP.2	Reason abstractly and quantitatively
MP.4	Model with Mathematics
MP.5	Use appropriate tools strategically
8.F	Define, evaluate, and compare functions.
S.ID	Summarize, represent, and interpret data on a single count or measurement variable
S.IC	Make inferences and justify conclusions from sample surveys, experiments, and observational studies
F.BF	Build a function that models a relationship between two quantities
N-Q	Reason quantitatively and use units to solve problems
MP.4	Model with Mathematics.
A.CED	Create equations that describe numbers or relationships.