Standards Analysis

Mike Mahoney

For the standards analysis, I examined the Common Core Math Standards, the ITEEA Standards for Technological Literacy, and the Next Generation Science Standards. Within each set of standards, I focused on the high school (9-12) level, as this directly related to my teaching assignment.

First, I will identify the correlation between the mathematics, technology, and science standards with problem solving and engineering design. Second, I will note similarities and differences between the standards and engineering design problem solving.

Common Core State Standards for Mathematics (CCSS)

CCSS focuses on eight mathematical practices, in the table below, I list each of the mathematical practices, and match them with how I see the correlation to the Dartmouth Design Process. Some of the steps in the design process can overlap or apply to more than one mathematical practice.

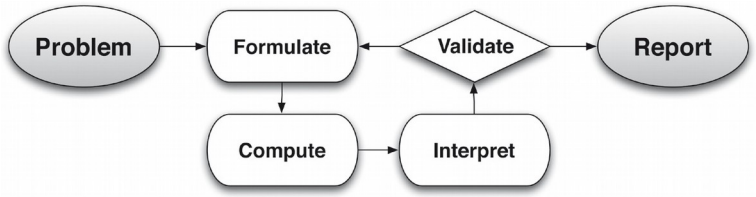
CCSS Mathematical Practices	Dartmouth Design Process
Make sense of problems and persevere in solving them.	Define the problem. Restate the problem.
Reason abstractly and quantitatively.	Develop constraints/criteria/specifications.
Construct viable arguments and critique the reasoning of others.	Brainstorm ideas. Research alternatives.
Model with mathematics.	Identify a potential solution. Design a potential solution. Construct a prototype.
Use appropriate tools strategically.	Analyze alternatives by a trade-off matrix. Research in detail the potential solution. Design a potential solution.
Attend to precision.	Design a potential solution. Construct a prototype. Evaluate prototype.
Look for and make use of structure.	Research in detail the potential solution. Design a potential solution. Evaluate prototype. Reiterate if necessary.
Look for and express regularity in repeated reasoning.	Simplify if possible.

The CCSS Mathematical Practices are related to problem solving and engineering design (the Dartmouth Design Process) through the practice of **Mathematics-High School-Modeling**. Modeling links mathematics to everyday life, work and decision making. Modeling helps students understand problems better and improves their decision making skills. The CCSS Problem Solving Model is a flowchart that has a loop that is

Standards Analysis

Mike Mahoney

related to the reiterate step in the engineering design process.



The difference between the CCSS Mathematical Practices and engineering design is that in CCSS, the problem is to solve is a mathematical problem, not necessarily related to a real world human problem as would be addressed by engineering design problem solving.

Next Generation Science Standards (NGSS)

NGSS has science and engineering integrated into the standards. Highlighted in green is the performance expectation for Science and Engineering.

Example: *High School Physical Science*

HS-PS1-6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*

The specific standards that incorporate engineering design are as follows:

Physical Science: HS-PS1-6, HS-PS2-2, HS-PS2-6, HS-PS3-3, HS-PS4-5
Life Science: HS-LS2-7, HS-LS4-6
Earth and Space Science: HS-ESS3-2, HS-ESS3-4
Engineering: HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4

Part of the engineering design process is to take into consideration the natural world (science). The similarities between NGSS and engineering design problem solving stem from the integration of engineering design in each science standard. Using natural phenomenon to engineer a solution to a problem. The difference is that science is looking for answers to explain nature, and engineering is using what is known about nature to solve human problems. The standards may emphasize the Scientific Method over the Engineering Design Process, but this doesn't mean the two can't be used together.

ITEEA Standards for Technological Literacy

ITEEA standards are related to problem solving and/or engineering design through the following standards:

Standard 8 – The attributes of design.
Standard 9 – Engineering Design.
Standard 10 – The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
Standard 11 – Apply the design process.
Standard 12 – Use and maintain technological products and systems.
Standard 13 – Assess the impact of products and systems.

The similarities between ITEEA standards and problem solving or engineering design is that ITEEA specifically describes the design process as: defining a problem, brainstorming, research and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results. This very closely aligns with the

Standards Analysis

Mike Mahoney

Dartmouth Design Process. I see very little difference between the ITEEA standards above and engineering design problem solving.

I think there is great benefit to incorporate engineering design problem solving as a unifying concept or skill. There is a natural correlation between science, engineering problem solving, technology, and math: science describes nature, engineering uses natural phenomenon to solve problems, technology is the result of engineers applying their understanding of the natural world, and math is used to model and explain solutions. If we want to give students the tools to be great problem solvers, we need to integrate science, technology, engineering, and math **(STEM).** One without the other is disjointed and fails to present the all the tools needed to be great problem solvers.