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Standards Analysis  
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## Standards Analysis

### Which technology education, mathematics, and science standards relate to problem solving or engineering design?

There are several technology education, mathematics and science standards that relate to problem solving and engineering design. Comparing the Common Core State Standards for Math, Next Generation Science Standards, ITEEA Standards for Technological Literacy and National Council of Teachers of Mathematics Standards there are numerous standards that directly reference problem solving or engineering design. For instance, the NCTM process standards include a problem solving section in which "Instructional programs from prekindergarten through grade 12 should enable each and every student to, build new mathematical knowledge through problem solving, Solve problems that arise in mathematics and in other contexts, Apply and adapt a variety of appropriate strategies to solve problems and Monitor and reflect on the process of mathematical problem solving". (NCTM)

ITEEA Standards for Technological Literacy's standards 8, 9, 10 and 11 all focus on engineering design and problem solving. Standard 8 is Students will develop an understanding of the attributes of design, 9 states "Students will develop an understanding of engineering design" and 10 reads "Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation and the experimentation in problem solving". Standard 11 states, "Students will develop abilities to apply the design process." (ITEEA)

Common Core Math also incorporates problem solving and engineering design in their standards which is visible in Standard 10 "The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving." Looking at the Common Core Math grade 3 standards, I found that standard 3.MD.8 was relevant in problem solving, "Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different area or with the same area and different perimeters". 3.OA.D.8 also highlights problem solving. "Solve two-step word problems using the four operations. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding." (Common Core Mathematics)

In the NGSS grade 3-5 standards, 3-5-ETS1-1., 3-5-ETS1-2. And 3-5-ETS1-3., "Students who demonstrate understanding can: "Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.", "Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.", and "Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved." (NGSS)

### How are these standards similar to each other? How are they different from each other?

These standards share many similarities in some of their verbiage. Nearly all use the words “problem solving”, “solve problems”. It is very clear that each of these organizations are placing an importance on the “how-to” when it comes to finding answers. In short, the standards are encouraging teachers to intentionally provide instruction about “problem solving”.

There are several notable differences in these standards as well. Each organization is presenting “problem solving” and “engineering design” through their own lens, however, its clear that the vocabulary of problem solving doesn’t necessarily translate across each. Several of the standards include the words “utilize strategies”, “develop understanding”, or “troubleshoot”, but it doesn’t seem that there is a uniform lexicon for finding ways to come to an answer.

### What are your thoughts on engineering design problem solving as “unifying” concept/ skill?

It is inspiring to me to see that educators are uniting in recognizing the importance of teaching “problem solving”. We have expected students to come to us with an understand of how to find answers, big and small, but it was very infrequent that those skills were actually taught, either at the K-12 level, or in an Educator Prep program at the collegiate or graduate level. I was particularly interested in the Jonassen article, Toward a Design Theory of Problem Solving. He poses the question, “Why are we so inept at engaging learners in problem solving?” and argues that “Problem solving has never been sufficiently acknowledges or articulated in the instructional design literature. (Jonassen) He points out that the types of problems that we are requiring our students to solve vary and in turn, we need to recognize those differences and tailor our instruction to incorporate a variety of problems and solution finding opportunities to our students. I am uplifted to see that the greater education community is moving toward exploring problem solving as a subject matter of its own. In the Garmire article, The Engineering Design Method, the author lays out a set of steps for design processing. These steps are as follows: Define the problem, Restate the problem, develop constraints and criteria (specifications), brainstorm ideas, research alternatives, analyze alternatives by a “trade off matrix”, identify a potential solution, research in detail the potential solution, design a potential solution, construct a prototype, evaluate prototype, reiterate in necessary and simplify if possible. (Garmire) Sharing a design process similar to this with students allows students to see the actual though process required in problem solving. This process applies to so much more than a “science project” that students are required to complete in the classroom. This type of direct instruction shows the metacognition involved in our daily lives. Humans process the choices they have throughout the day in a similar way, but rarely stop to explore the thought process. I do think that utilizing a common language in important to begin to teach problem solving and engineering design and would be a unifying skill across education as a whole.

Garmire, Elsa, (2003, December/January). The Engineering Design Method. The Technology Teacher. Retrieved from [file:///Volumes/JetDrive/Endeavor/Garmire\\_2003TTT.pdf](file:///Volumes/JetDrive/Endeavor/Garmire_2003TTT.pdf).

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