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Standards Analysis: Technology Education, Mathematics, and Science Standards

Common Core Math Practices, Next Generation Science Standards, and ITEEA Standards have components that support student learning for real life problem solving and engineering design. Common Core Math Practice 4 specifically asks students to make mathematical models that solve real life problems. Students are asked to use their knowledge of math and ability to extract and simplify data to write out the relationships, trends, and patterns seen in real life examples. They can use math to support a solution for multiple situations and revise their model as necessary given more information.

NGSS has a unique standard for engineering design specifically: HS-ETS1 Engineering Design. In this science standard, students take a real life problem and break it up into manageable systems that can be modeled with computer simulations. The problems can be solved through engineering design that takes into account the many facets of large problems, including financial and environmental costs, cultural and societal ethics, safety, and aesthetics.

ITEEA has a couple standards specifically related to engineering design. “Standard 11: Students will develop abilities to apply the design process” has students identifying problems, use prototypes and modeling for designing and refining solutions, and use mathematical models to evaluate a design.

All three standards focus on students looking at real life problems. Students are asked to identify a problem and determine the relevant data needed to address the problems. The problems are real, complicated, and demand mathematical models to be used in the process. All three use mathematical models to be used as a tool for analysis and to be used for revision purposes. All standards also imply that there will not be one correct solution to the problems given to students. Students will come up with a solution and use data and mathematical models to support their solution.

The similarities of the standards are abundant with differences in the details. ITEEA is the only standard that specifically has students make prototypes for purposes of refining a design. While all standards here mentioned identifying constraints to the problems, NGSS specifically mentions cultural, societal, and environmental impacts of designed solutions should be evaluated. NGSS engineering standards includes the aspect of engineering of what a society wants or needs and implies that compromises will be made to optimize benefits of constraints. NGSS HS-ETS1 also does not mention like CCMP and ITEEA that students will be refining and making revisions to their solution or model, however revisions is a part of NGSS's Nature of Science and in the Science and Engineering Practices.

My own personal thoughts on engineering design problem solving is that it is absolutely a creative skill that needs to be taught at all levels in the classroom. A big reason that I teach is to help support children who are on their way to being productive and helpful members of society. Every single person will encounter problems in their life. It could be as mundane as a slippery stair, a messy house, or traffic. Some of our students may become inspired to be leaders to solve bigger problems. Every real life problem deals with relationships and we need students to start learning how to collect data, recognize problems, and use math to simplify a problem into solvable relationships. Another aspect of the unifying aspect of engineering design is the communication skills needed to work through this process. Even if a student can solve the world's most complicated problems, the student must be able to communicate effectively to gain support for their solution.

Standards cited

CCSS.MATH.PRACTICE.MP4 Model with mathematics.
Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high

school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

ITEEA: Standard 11: Students will develop abilities to apply the design process

M: Identify the design problem to solve and decide whether or not to address it.
N. Identify criteria and constraints and determine how these will affect the design process.
O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product
P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.
Q. Develop and produce a product or system using a design process
R. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.

NGSS: HS-ETS1 Engineering Design

HS-ETS1-1.	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-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.
HS-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.
HS-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.