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Problem Solving and Engineering Design: A Unifying Concept?

The CCSS have eight mathematical practices that can be found throughout the content standards. This is a similar setup to the NGSS, where you find science and engineering practices that are integrated throughout the DCI, and the eight practices found in the ITEEA standards also integrated into the context standards. A student proficient in mathematical practices should be able to make sense of problems and persevere in solving them (MP1). This focuses on the process involved in solving problems and not just following procedures to get an answer. Students need to first understand what the problem is asking and identify important information. In the science and engineering practices found in the NGSS students learn to ask questions and define problems, specifically the criteria and constraints (MSETS1-1). Once again, students need to understand what is in front of them, what they are being asked to do, and any restrictions or requirements they might see. The first practice listed in the ITEEA standards for Technology and Engineering students should be able to think systematically. To think systematically students should see that problems or tasks are connected to other problems they may have encountered in the past. They should also understand that their design or problem is part of a much larger system, which in turn, projects constraints to the problem. All three areas, math, science, and technology and engineering, place an emphasis on understanding the problem at hand and the criteria and constraints that go along with it.

The creativity needed for innovative thinking and designing goals, that is found in the second practice of the ITEEA standards is also seen in both the NGSS and CCSS. MS-ETS1-2 states that students should be able to evaluate and find ways to solve problems. This takes creativity and the ability to make connections to previous problems they have encountered. To be a good problem solver students need to be able to model and apply the math they already know to everyday problems they might encounter (MP4). They need to develop the habit of looking for patterns and making use of structure in order to solve problems (MP7). Without the creativity and perseverance of a good problem solver students will rely on memorized facts and procedures and never be able to apply their content knowledge to various life situations.

The ability to communicate and construct convincing arguments with precision is a common theme in the mathematical practices, science and engineering practices, and the technology and engineering practices. An engineer is asked to understand society's wants and needs and also be able to defend their design choices. A scientist needs to be able to construct convincing arguments with evidence that supports their claim. A mathematician must be able to communicate precisely with clear definitions, explaining any symbols that they might

have used. Communication is a key practice that unifies math, science, and technology and engineering.

The major difference between the CCSS, NGSS, and ITEEA is found in the actual content of the subject. While solving problems and designing solutions for society's needs with energy and power, one of the eight context standards in the ITEEA, might see some overlap with earth science standards found in the NGSS and statistics and probability or ratios and proportions in the CSSS, the objective behind the standard might be different. For example, math might teach ratios and proportions, how to set them up, solve them and apply them to other problems to possibly make predictions. Science might teach about the natural resources available and the use of alternative forms of energy and how that works. But technology and engineering might actually make or design a solution to earth's need for alternative energy. Each content area teaches certain context and knowledge that can then be applied to everyday problems.

Math, science, engineering, and technology content area teachers need to work together to develop future problem solvers and engineers. Teaching students to be real problem solvers is a huge and difficult task that requires unity among all content area teachers. If content is taught alone without the practices being integrated, then procedures are learned, repeated, and then forgotten. However, if skills and practices are taught in all content areas students will develop the necessary skills to be productive and successful in a rapidly changing world. Engineering, and its practice of making and doing, encompasses the NGSS science and engineering practices and the CCSS mathematical practices. Engineering design problem solving is the unifying practice of these disciplines.