Engineering Standards Analysis

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Science, Technology, Engineering, and Mathematics (STEM) disciplines are naturally integrated. When comparing problem solving and the engineering design process to the science, math and technology standards, there are several ways that the standards in each of these content areas show similarities and differences. Even with some differences, problem solving and engineering design can be considered to be a unifying a skill and concept across the Science, Technology, Engineering, and Mathematics (STEM) disciplines.

The Next Generation Science Standards NGSS standards that relate to engineering design concepts are ETS1 Engineering Design for K-2, 3-5, middle school, and high school. There are similarities with the engineering design concept for all grade levels, but the degree of detail in the design process differs depending on each grade level. In the K-2 standards students are expected to demonstrate an understanding of the following components of the engineering design process: defining simple problems, developing simple drawings or models, analyzing the data from tests. In the grades 3-5, students build upon the K-2 standard by solving a problem with specified constraints and comparing multiple possible solutions. The middle school engineering design standards expect students to use relevant scientific principles and potential impacts on people and the environment when defining the problem, evaluate the design solutions using a systematic process, analyze data from tests more deeply, and makee modifications to optimize the design of the product. Finally, in high school students are expected to use the entire engineering design process for complex real-word problems and use a computer simulation to model the possible solutions. As students get older, they learn the engineer design process in greater depth.

Problem solving and engineering design concepts are also evident throughout the ITEEA Standards for Technological Literacy. Some of the key similarities between the engineering design process and ITEEA standards are as follows:

- *Standard 1: Students will develop an understanding of the characteristics and scope of technology* - In grades 6-8, students learn that technology helps develop new products or systems and is linked to inventions of people's needs and wants. This is similar to the creation of new technology as part of the engineering design process.
- *Standard 2: Students will develop an understanding of the core concepts of technology* - In grades 3-5, students recognize there are limits to designing a product or system which is essential information for the engineering design process.
- *Standard 8: Students will develop an understanding of the attributes of design* - Technological design needs to be systematic because there are many different designs and approaches to solving a problem. It also states that the design process is not a linear process. It is a repetitious process that allows designers to explore different ways to solve problems. This is similar to the idea of circling back and repeating steps in the engineer design process.

- *Standard 9: Students will develop an understanding of engineering design* - This entire standard for all grade levels is dedicated to students learning the engineering design process.
- *Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovations, and experimentation in problem solving* - Research and development is a subset of the problem solving process that is central to engineering design. Invention and innovation provide creative approaches to solving problems, as is the case with the engineering design process.
- *Standard 11: Students will develop the abilities to apply the design process* - This clearly shows how utilizing a problem-solving design process is an important component of technology standards.

While the above ITEAA standards offer similarities to the engineering design process, Standard 10 illustrates some differences, as students learn that the engineer design process is not the only type of problem solving process. Some different approaches are troubleshooting and experimenting. Troubleshooting requires the problem solver to eliminate possible explanations and focus on the source of the problem where there is one solution, where as engineering design will look at a wide range of solutions before focusing on a specific solution. While engineering design is creating solutions to problems, experimenting is more about answering questions. This provides some distinction in the approach between the ITEAA standards and the engineering design process.

Problem solving is also visible throughout the Common Core Mathematics Standards. Within these standards, students are expected to solve mathematical and real-life problems. Particularly in the Ratio and Proportional Relationships domain, students must analyze proportional relationships and use them to solve real-world and mathematical problems. Problem solving is also relevant in the Expressions and Equations domain where students are expected to solve real-life and mathematical problems using numerical and algebraic expressions and equations. Both domains are similar to problem solving and engineering design concepts, in which students are asked to find solutions to real-life problems by generating ideas on how to evaluate the problem, possibly model, solve, and then communicate the results. The engineering design process is for solving real world problems as opposed to computational mathematics. The engineering design process is also different than solving problems in these math standards because a student does not need to identify and research the problem, because in most cases all information is given.

Engineering design and problem solving are woven throughout the science, technology and mathematics standards. While there are some differences in problem solving approaches throughout these standards, there are several similarities in the engineering design method to problem solving. With the amount of similarities engineering design has with these three standards, it is clear that engineering design and problem solving is a unifying concept across the STEM discipline areas. This unifying concept is important because it teaches students analytical, collaboration, and communication skills, application of core subject areas, and creativity throughout the

problem solving process. While students use the engineering design process they learn from failure. These critical skills are beneficial for students in their careers in any field.

References

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