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Standards Analysis

The engineering design process is an iterative cycle in which you begin by asking what is the problem or goal to be addressed. This is followed by brainstorming and imagining possible solutions to the problem as well as the criteria, constraints, and resources available. Once this has been determined, a plan or blueprint can be developed to express and delineate the path that will be followed. It is at this point one can create a model or prototype that can be tested and evaluated for effectiveness. The design can then be improved and the cycle continues.

In an effort to examine educational standards and analyze how they overlap in the area of engineering design and problems solving, I have chosen to research the New Jersey Science Standards, the ITEEA Standards for Technological Literacy, and the Common Core Math Standards and compare them to the model of the Engineering Design process. I have chosen to focus on specific standards that are addressed in grade 3 for each of the standards.

The New Jersey Science Standards were written to align closely with the design process by incorporating specific engineering standards. For the purpose of this analysis I have chosen to include standard 3-5-ETS1: “Define a simple design problem

reflecting a need or want that includes specified criteria for success and constraints on materials, time, or cost." I will also include a grade level specific standard for 3rd grade physical science 3-PS2-4: "Define a simple design problem that can be solved by applying scientific ideas about magnets" (New Jersey Department of Education, 2016).

According to the ITEEA at the 3rd grade level, "the design process is a purposeful method of planning practical solutions to a problem. The requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design."(ITEEA, 2007). For the purpose of analyzing the standards, I have chosen to look specifically at standard 9c: "The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results" (ITEEA, 2007).

It was difficult to pinpoint a specific standard in mathematics that would directly relate to engineering design, the mathematical practices incorporated in the common core state standards speak directly to problem solving. While the connotations for "problem solving" may differ from those used in the science or technology standards, the fact that they were attempting to address real-world scenarios was helpful. For the use of this comparison, I will look specifically at Standard 1: "Make sense of problems and persevere in solving them." As a specific standard for 3rd grade, I will reference CCSS.MATH.CONTENT.3.MD.D.8: "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 areas or with the same area and different perimeters.”

These standards overlap and are similar in the fact that they all address real world scenarios and/or problems in which the skills and knowledge of core content is applied. Each discipline suggests that the students are given the skills and understanding necessary to solve a problem and then applying them to a situation or scenario that they might encounter in the real world.

The the technology standards, while one would expect them to address online content and troubleshooting have been written with the idea that technology is anything designed by man to solve a problem. So, if engineering is designing solutions to problems, then the outcome of the engineering process is often “technology”. This makes it easy to relate the science standards to the technology standards in that the science standards. The difference being that the science standards would include knowledge of a specific scientific concept as a means to create the technology through the engineering design process.

It is more difficult to see connections to the math standards when the specific wording of the standards is applied. The “real world problem solving” usually refers to word problems or scenarios that might happen in the real world, but would not require creative thought to achieve an answer. In addition to this, mathematical problems usually have one correct answer. Alternatively, in technology and science, there may be multiple avenues to solve a problem.

Through the use of the engineering design process, each of these standards can

be unified into one method to teach and apply necessary skills. Here is a scenario in which the engineering design process can unify the other standards. Students are given a challenge. They are to design a maglev train that travels the fastest and carries the largest number of passengers. In order to begin solving this problem, the students will need to to perform scientific investigations on magnets, learning about magnetic attraction and repulsion as well as ways to increase the strength of the magnetic field. This would address 3-PS2-4. Once the students have learned the science behind magnets, they are shown the maglev track and the materials they will be allowed to use to make the train (note cards, tape, magnets) as well as the fact that the passengers will be pennies. They are given a budget for each of the materials and told that they must stay within the constraints of the budget in building the train. This addressed 3-5-ETS1 as well as giving a real world opportunity to work with adding and subtracting currency and understanding the value of money. This is not a skill specified in the 3rd grade curriculum,is arguably still be a valuable skill to review and reinforce. As the students are planning the train, the teacher can introduce CCSS.MATH.CONTENT.3.MD.D.8 and use the perimeter of the note card as a means to discuss ways to improve the capacity of the train to hold passengers. That by changing the perimeter, students can make more room for more passengers. So, in the true nature of STEM, it is possible to use the engineering design process to unify the standards, associates with each of the associated fields of learning; science, technology, and math.

References

“Grade 3.” Grade 3 | Common Core State Standards Initiative, www.corestandards.org/Math/Content/3/.

“New Jersey Department of Education.” New Jersey Student Learning Standards: Science, www.state.nj.us/education/cccs/2016/science/.

Standards for Technological Literacy: Content for the Study of Technology. International Technology Education Association, 2007, *ITEEA*, www.iteea.org/File.aspx?id=67767&v=b26b7852.