

Standards Analysis Assignment

Over the past several years, there has been a shift in the goal of education in science and mathematics from stand-alone courses that impart declarative knowledge to the more integrated curricular goal of STEM, where procedural knowledge of solving problems and engineering apply the declarative and results in learners becoming more active and better problem solvers. Problem solving and engineering design are skills and processes that involve cognitive, behavioral and attitudinal components which will be both indicators of the success rate and will hone the skills toward the ability to solve more complex and poorly structured problems. (Kirkley) These skills are not stand-alone skills, either, and are best learned in context where students can find relevance and applications to the real world. As such, the new standards in science, mathematics and technology each outline disciplinary core ideas, where one can see the problem solving and engineering applications woven into the curriculum. With a closer examination of the standards, it can be said that engineering is a unifying concept for the three other disciplines.

In examining the standards for science, mathematics, and technology, each discipline has components that relate to problem solving and/or engineering design. Additionally, the three also overlap in many ways, as the integrated STEM curriculum intends. As the grade bands progress, each standard has a more evolved and intricate relationship with engineering thinking and problem solving.

In science, the NGSS Disciplinary Core Ideas include the following that incorporate or relate to problem solving and engineering design: asking questions and defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, and constructing explanations and designing solutions. (NGSS)

In math, the NGMLS Disciplinary Core Ideas include the following that incorporate or relate to problem solving and engineering design: make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate tools strategically, attend to precision, look for and make use of structure, look for and express regularity in repeated reasoning. (NYS-NGMLS)

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In technology standards, all of the eight core ideas outlined in the Standards for Technology and Engineering Literacy are engineering related. These include: nature and characteristics of technology and engineering, core concepts of technology and engineering, integration of knowledge, technologies, and practices, influence of society on technological development, design in technology and engineering education, and applying, maintaining, and assessing technological products and systems. Each of the ideas really incorporates engineering in one shape or form, whether it is using problem solving or designing solutions or improving situations. (STEL)

These standards are all similar to each other as they emphasize not just the acquisition of knowledge, but the ability to use the knowledge to solve problems, which is an essential engineering practice. They all involve defining problems, using models, constructing arguments, collaboration, using computational thinking processes and perseverance in problem solving.

The standards differ from each other mostly in the context within which they will be addressed. Science will address the standards across living systems and the physical world, while mathematics will address standards using more than just science applications, but areas like statistics and architecture. Additionally, the two types of problems, whether they fall into the well structured or ill structured (Jonassen) may not be evenly represented across all three content areas. Depending on the discipline or grade band, a problem in science or math will vary in the degree of skills, practice, modeling or iterative cycle of problem solving involved.

Engineering design problem solving is a necessary and absolutely “unifying” concept/skill. In examining the standards for science, technology education, and mathematics, the threads for integrating problem solving and engineering design are woven consistently throughout the fabric of all three subject areas. The NSTA Position Statement on STEM Education Teaching and Learning delineates these standards and that the instruction is to be “grounded in constructivism.” (NSTA) Constructivism involves a shift from students being “active knowers to active learners.” This type of learning is accomplished through activities that are designed as inquiry or project based, with opportunities to collaborate and solve problems. (Buffalo)

“Is There a Nature of STEM,” by Erin E. Peters-Burton, states that a multi-disciplinary STEM will integrate design, inquiry and analysis, which are tenets of the engineering process. She goes on further to describe each of the disciplines of STEM and how they interact with each

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other: “two harmonious sides of the same coin,” where science and math uncover the secrets of the world and engineering and technology shape the world. This idea is consistent with the two types of knowledge Jamie Kirkley describes as declarative and procedural, where the latter is grounded in problem solving, an essential task of engineering. (Kirkley) In addition to reviewing standards among the three areas of science, mathematics and technology, reading documents that elucidate just what engineering thinking (computational) and problem solving processes encompass, it is evident that engineering is the unifying feature of STEM.

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