Case Study I: STEM is everywhere

"Pick up a pen and take a close look at it. Do you think this is a piece of technology? If you're like most people, you probably answered no. We tend to think of technology as just things we plug in; in fact, however, technology is anything that is made by humans and used to solve a problem.

The pen certainly solves a lot of problems, and it's very convenient. Let's look at this pen a bit closer. Are there different parts that make up the pen? How many would you get if you took it apart? What happens if you touch the point of the pen to your tongue? Do you think that ink would harm you? (It would not, because this ink was developed and tested by biochemists who made certain the ink was not toxic.)

The physical properties of your pen (hardness, durability, and mass) and the way the parts function together result from the calculations of mathematicians and the design choices of engineers who worked in interdisciplinary teams to develop it. The humble pen in your hand is an excellent example of technology based on science, engineering, and mathematics.

Case Study II: A STEM experience

A group of 5th grade students are learning about force and motion in science and about data analysis in math. They work in teams to design roller coaster tracks out of cardboard boxes and tubes. As a first step, they use a measuring tape, marbles, masking tape, and several sections of plastic track to learn how a marble moves along the track. They are instructed to measure, in one-second intervals, how the marble accelerates as it rolls down the inclined track. The students plan and conduct the experiment without detailed instructions. Each group compiles its data into a graph, applying the data analysis methods they have studied to choose the appropriate type of graph (for example, bar or line) and what data to use (mean, median, or mode).

Then the class compiles all the data into one graph that represents the data from all the groups. To do so, they have to debate and decide issues related to the science and math concepts they are learning. For instance, the students see that one group's set of data differs greatly from the others, and on further investigation they learn that the reason is because that group chose a different level of incline for its design. Thus, instead of just being taught the statistical concept of outliers, the students gained an authentic understanding of this concept.

During the roller coaster activities, these students are experiencing transdisciplinary integration—more commonly referred to as problem-based or project-based learning—which is the most advanced level of STEM teaching and learning. Transdisciplinary integration, grounded in constructivist theory (Fortus, Krajcik, Dershimerb, Marx, & Mamlok-Naamand, 2005), has been shown to improve students' achievement in higher-level cognitive tasks through the application of scientific processes and mathematical problem solving (Satchwell & Loepp, 2002).

Throughout this transdisciplinary experience, the students were applying the new content they had learned in their mathematics (data analysis) and science (force and motion) classes to solve an authentic problem that was of interest to them. They were increasing their communication and collaboration skills as they worked in small groups and then compiled their group results. They were also practicing the engineering design process as they defined the problem they needed to solve (to build the roller coaster);

Students developed a solution as a group, agreeing on a plan or blueprint; and optimized their design (tested whether the roller coaster ramp worked correctly and whether they could collect the data they needed).