



UTeach Maker - Showcase Lesson Overview Arami Rosales (Spring 2019)



Lesson Title	A Twist in the Marble Run
UTeach Maker	Arami Rosales
Name of collaborator/s	Eric Shaffer
Subject and grade level	Introduction to Engineering Design (primarily 9th - 10th graders but 11th and 12th graders are also present)
Link to lesson plan and materials	https://star2019.weebly.com/showcase.html

Lesson Description:

A Twist in the Marble Run is a unit I designed that aligned with the standards of PTLW but was not in the original curriculum. This unit requires students to use the engineering design process to create a paper roller coaster by first starting with research and plan development, building components and testing their roller coaster, and finally presenting their final product to community members. This unit helped build students confidence in themselves, taught them about failure, and showed them how important writing and reading is in STEM careers. This was the first hands on maker experience these students had.

Lesson Development:

My main goal in developing this lesson was to motivate students to push through adversities and accomplish whatever goal they set their eyes on. I wanted to create a project that would give students a sense of ownership over their own abilities and encourage them to never give up. Up until this project, most of their projects had been done using AutoDesk Inventor, a computer aided design software. They followed video tutorials to accomplish some a goal with limited independence, but they didn't have to think about WHY things worked.

Paper roller coaster projects are very common in physics classes to teach students about speed and acceleration. I took this concept and altered it such that it would suit a freshman engineering class. I shifted the focus away from the physics and instead placed it on the development process of engineering.

Lesson Implementation:

Introduction to Engineering Design is a Project Lead The Way course. It is the freshman level engineering course that mainly focuses on computer aided design. Though this is definitely a type of Making, many students over 3 sections had a difficult time taking ownership of their work because most of them followed video tutorials instead of experimenting and overcoming failure. Because of this, many of my students were resistant to the independence they were given and many said they were afraid of failing because there were no direct plans for them to follow. Eventually, many students fell into the rhythm of build/test/redesign/rebuild. Most were even eager to be given the next challenge after that.

Each section has a mix of grades for a total 34 freshman, 19 sophomores, 6 juniors, and 1 senior. Of the 60 total students in these sections, 55 of them are Hispanic and of those many have IEPs or are ELLs.

Students spent time researching different design factors by looking at sample roller coasters to get an idea of what their challenge was. They also participating in a lab intended to show them the different variables that could impact how the marble travels down the roller coaster. This was meant to show them how research is important even in the engineering world.

The next class, the students went through stations showing off different construction techniques to help them generate ideas of how they could succeed. This separates this project from others like it -- my students had to create their own 2D patterns or nets instead of using templates provided to them, a PLTW standard. This project was also unique in this class because it was the first time students had to work together. Integrating teamwork into this project definitely changed the dynamic of this class.

Towards the end of the construction process, many student's roller coaster failed due to the weak tape and a humid classroom. However, everyday they would come back in and restart their construction process. They learned perseverance. Shaffer helped develop and alternate solution so that some teams could be successful. We whipped out the duck tape, unified some groups, and got to building. At the end, students presented their roller coasters to each other and members of the school community. The students ended 6-weeks by writing a reflection about the project, discussing successes they were proud of and how they think this project will help them in the future.

Connection to important concepts and skills within the discipline and/or across subject areas:

Communication skills and grit are highly valued characteristics in engineers. As an engineering teacher, I want to prepare my students the best I can to success in industry. Also, engineering lends itself well to both math and science. The concept for this project was taken and modified from a classic physics project to suit the engineering standards below:

- KS1.1.1 Plan and use time in pursuit of accomplishing a goal without direct oversight.
- KS1.2.2 Use praise, setbacks, and feedback to positively influence one's professional development.
- KS1.4.5 Create and identify flat patterns that can be folded into specified three-dimensional shapes, and identify three-dimensional shapes that are represented by specified flat patterns.
- KS2.2.1 Explain the role of research in the process of design.

- KS2.5.2 Produce a physical model using hand tools and simple construction techniques.
- KS10.1.1 Describe the importance of team norms and develop those norms for a team.
- KS11.1.1 Communicate effectively with an audience based on audience characteristics.

Reflection:

This lesson was taught to 3 sections of Introduction to Engineering Design. Like many teachers, after each iteration of the lesson I made changes to improve the delivery and content. This version that I have submitted includes a built in day for students to rotate through different construction techniques. This was not originally implemented but was created when students were unable to begin to construct on their own and asked for some guidance.

The original implementation of this lesson also lacked a direct outline to help students stay on track. One of the PLTW standards is to have students learn how to manage a project by themselves, so I wanted to focus on this. However, I didn't take into account the fact that these students had never been in that type of environment. I had to create a little more structure for some students and build that into this lesson, though I am sure there are schools that would not need the direct oversight of the instructor.

Designing this curriculum from scratch was rather difficult. Having to create the timeline, activities, worksheets, info sheets, and weekly PowerPoints is so much work. I should have asked for more help and direction during this process, but I didn't want to be a bother. It was definitely eye opening though. It takes a tremendous amount of time to plan a unit and even if you feel like you've planned the best possible unit, you will still run into issues. Being flexible and adaptable are skills I saw my cooperating teacher had that I didn't. Seeing him quickly alter plans so that students would be successful was a great learning experience.

I enjoyed teaching this unit though sometimes I wonder if I spent too long on it. I still think back and ask if the amount of time spent was worth the learning outcome but through this process, I think I made the correct decision. My students face failure head on now. Some have taken a liking to CAD because they see it as a challenge to be defeated now. They are willing to try new things and are confident in their ability to succeed. All of my students are excited about engineering and see it as a possibility for them.