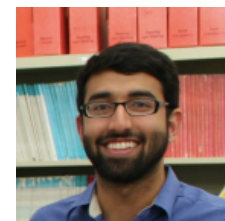




## UTeach Maker - Showcase Lesson Overview Abdulkarim Bora (Fall 2017)



Project Title	<b>Cars: A Crash Course on Momentum</b>
Name of UTeach AT	<b>Abdulkarim Bora</b>
Subject and grade level	<b>9th Grade, Physics First</b>
Link to lesson plan and materials	<a href="https://uteachakb.wordpress.com/lesson-resources/pbi-maker-momentum-lesson/">https://uteachakb.wordpress.com/lesson-resources/pbi-maker-momentum-lesson/</a>

### Lesson Description

There are three phases to the project. Phase 1 involves building a base car using wooden parts that were laser cut and placed in sandwich bags for each student. In Phase 1, students are paired with another student and these students must collide their cars head-on on a ramp setup in the classroom. Students take a video of their collision and analyze the momentum, impulse, and forces in the collision. In Phase 2, students are presented with design challenges that relate to momentum, where they must use given materials to modify their cars. The design challenges are adding to the car to either decrease velocity, decrease the impact of the force of the collision, increase mass by adding an egg on the car, or a student choice design challenge that must be approved by the teacher. Next, students repeat the slow-motion video recording of the collision and analyze the momentum, impulse, and forces. Finally, in Phase 3, students present their modifications for their design challenges and reflect on how it changed the car collision. Additionally, students submit a written report where they also note what future modifications they would make based on the Phase 2 collision analysis.

### Lesson Development

As part of the UTeach Maker program, I needed to implement a Maker lesson during my Apprentice Teaching semester. I talked to my cooperating teacher about it, and he gave me the freedom to try a Maker lesson in his classroom. My high school, Manor New Tech High School, is a project-based school, where students are used to learning in all classes through projects. My teacher and I looked at the curriculum for the year and we decided that my lesson could focus on momentum. Previously in class, we did a project on car safety involving Newton's Laws. I thought I could continue with the car theme for my Maker lesson.

Studying momentum often involves collisions of two objects. Initially, I thought that students could crash remote control cars, but that

would be expensive to purchase for everyone. Then I thought students could crash cars with eggs on them and try to protect the egg from cracking. However, this required the little cars crashing to have enough force to crack the egg in the first place. I thought students could make mousetrap cars so the mousetrap could propel the cars, but then I realized that a ramp setup will be easier to make the cars start moving.

## **Lesson Implementation**

I was an apprentice teacher at a school where they teach Physics First. This means that physics is the first science class high school students take when they enter 9th grade. I taught the two Regular sections of Physics, which contained the students that were in Algebra I. Most of my students were minority students and a majority of the students at the school are low-income. The students were used to Project-Based learning since this project was implemented late in the fall semester. In a survey I gave to my nearly 60 students, many of them wrote that they wanted to do hands-on activities. This lesson delivered upon their request.

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

The conservation of momentum is an idea that is paramount to the subject of physics and the way the world works. The specific Texas state standards covered by this lesson are

- P.6C - calculate the mechanical energy of, power generated within, impulse applied to, and momentum of a physical system
- P.6D - demonstrate and apply the laws of conservation of energy and conservation of momentum in one dimension.

It is important to note that the standards that were covered above were only related to momentum, as energy would show up in the next project. The lesson also incorporated other disciplines including engineering and math. The engineering showed up when students were building wooden cars, using limited supplies to modify their cars for a specific design challenge, and testing out their modifications by crashing the cars. They then reflected on whether their modified car design achieved its purpose, and if not, how they would further modify their cars. Students also had to do mathematical calculations to determine the velocity, momentum, and forces on their cars during the initial collision and in the collision after they modified their cars.

## **Reflection**

When I started my Maker lesson, I told myself and my cooperating teacher that this would be a learning experience for me and for my students. This stood true throughout the lesson as I reflect on what went well during the lesson and what could be improved for future implementations.

There was a lot that went well. This was the first time I tried giving students the whole assignment for the day or couple days up front and let them pace themselves in completing it. I walked around and stamped students' sheets as they completed a new section of their work, and this created a productive economy in the classroom where students were eager to get their work stamped. If students did not have their work complete, then I would not be able to stamp it, which drove them to ensure they completed their assignment fully.

The amount of creativity I saw from my students was astounding. They had ideas that I definitely would not have thought of, which is one of the most beneficial parts of incorporating open-ended Making in the classroom. Students will constantly surprise you with what they come up with. Students who I normally have a hard time getting to work were some of the most creative and crafty when it came to modifying and decorating their cars. Students were also genuinely excited for this project because they got to do hands-on things and be destructive in an organized, curriculum-based way in the form of crashing cars to study momentum.

Giving students the opportunity to present and share their work to the class was another highlight. Students were able to practice their public speaking and show off the work they put into their cars for two weeks. The presentations were a wonderful way to end the project and celebrate learning, whether students' cars worked as they wanted to or not.

There were several areas that could use improvement for the future. This is a 9th grade physics class where students are currently enrolled in Algebra I. The math that this project required was definitely challenging. I tried making it easier for the students by doing the first phase of calculations for them, so they could do it on their own in the second phase. Even so, my cooperating teacher indicated to me that the math would probably still be difficult for them, so I made them a "Phase 2 Calculations Help Guide" (which is available at this [link](#)). After this, the hardest part for the students was using the Slow-motion video to get the necessary information to do their calculations. Scaffolding this part of the project in a different way would be helpful. Perhaps I could go step-by-step in doing an example calculation with my own slow-motion video on the projector and students could follow along with their own videos.

Another area of improvement would be being available for all students as they move along at their own pace. Some students completed work quickly while others took longer. This meant most student pairs were at a different part of the project at a given time. While this was great because it kept the students busy, it made it difficult for me to monitor each student's progress, because then I would get overwhelmed and would not be able to keep up with stamping everyone's sheets, especially once students needed my help or had questions for me. One system I could employ to help is that as students come up with questions for me, they can write their names on the board, thus making a list. Then, as I move around the classroom assisting students, I could also keep an eye on the board and go to students who are waiting on me for help in the order written on the board.

Lessons are rarely perfect and rarely go completely as planned. That is why it is important to think ahead as to what student needs may

come up during the lesson and plan for those accordingly. It's also important to build in some flexibility so if something goes wrong, it will not stop the entire class from progressing. My students and I learned a lot from this project and I am sure they will remember this experience for years to come.