Mrs. Imelda Muñivez
Harlingen High School
1201 E. Marshall
Harlingen, Texas 78550

December 20, 2018

Dear Mrs. Muñivez:

This past summer I had the opportunity to participate in the National Science Foundation Enhancing Knowledge & Skills in Modern Manufacturing at Texas A&M University. For six weeks and under the leadership of Dr. Wayne Hung, Dr. Matthew Kuttolamadom, and Shelley Tornquist we were able to explore many topics in modern manufacturing such as:

- Technical Drawings
- Metrology
- Engineering Materials
- Porosity
- Lab Safety
- CNC Machining

This was a very interesting and complete program in which we acquired hands-on experience in machining, attended professional seminars, met with industry leaders, and got to develop curriculum which, with your permission, will be implementing in my Engineering Design and Development course. Attached you will find the lesson plan I plan to implement. Please let me know if further information is needed.

Sincerely,

Daniel Guajardo

Harlingen High School Principle Signature of ~~Approval~~

Daniel Guajardo **Engineering Design and Development**

Harlingen HS **Grades 11-12**

Harlingen CISD **20 days**

Enhancing Teacher Knowledge and Skills in Manufacturing

The objective of this lesson is to have students design components to meet specified needs within reasonable constraints. The knowledge acquired at the Research Experiences for Teachers (RET) program at Texas A&M University (TAMU) will be implemented in my Engineering Design and Development (EDD) course, specifically technical drawings, metrology, Computer Aided Drafting (CAD), and Computer Aided Manufacturing (CAM). The EDD curriculum requires students to work on a problem throughout the year while creating a working prototype. The new skills learned will supplement the current curriculum and be incorporated with the following TEKS:

§130.412. (5C) select appropriate mathematical models to develop solutions to engineering design problems;

§130.412. (5D) integrate advanced mathematics and science skills as necessary to develop solutions to engineering design problems;

§130.412. (5E) judge the reasonableness of mathematical models and solutions;

§130.412. (5K) use conversions between measurement systems to solve real-world problems.

Students are to go through the engineering process to design, model, and construct a prototype based on measurable requirements and develop an unbiased testing plan with qualitative and quantitative measures.

The approximate duration of the lesson is 20 days and is broken down into three segments. The first spanning 10 days and the subsequent 2 segments spanning 5 days each. The first 2 weeks of the lesson will be spent learning the ins and outs of the software Autodesk Fusion 360. Fusion 360 is a very comprehensive CAD/CAM program. I would like for at least one of my students to participate in Autodesk's Student Elite Program. In this program, students are paid to learn the software and teach fellow students how to use it. The student I have in mind is Tatyana Moore. Once Tatyana is trained, she could assist in implementing the lesson by teaching the software to both of my EDD classes. The main reason I participated in the RET Program was to get more girls interested in STEM careers. I strongly feel by getting Tatyana be a part of this program will encourage her, as well as other girls at my school, to follow a STEM pathway. On the second week we will be designing and manufacturing our prototypes by using a Stereolithography (SLA) 3D printer. On the third week of the lesson we will be verifying our dimensions by using metrology and comparing our results.

Days 1-10

The lesson will start with a demonstration of the software. The software will be projected onto the screen for students to see and emulate from their computer stations. This part of the lesson will be a group effort, having students collaborating with each other. We will learn how to draw basic shapes like triangles and cubes, followed by other commands such as modifying

dimensions, rotating the view of the object, and dimensioning. We will also explore other functions such as changing views from Model to Cam, to Simulation, to Render, etc. There are many features to this program, which is why we will take 2 weeks to learn the software and lay a sound foundation.

Days 11-15

The next section of the lesson will be spent designing and manufacturing a prototype using an SLA 3D printer. To start this part of the lesson we will go over the different materials and types of manufacturing techniques. Students will work individually to design a part of their choice with specified constraints. This will be a great opportunity to explore their creativity as well as take ownership and pride in their work while getting hands on experience with the design process. Once their design on Fusion 360 is complete, we will produce technical drawings. Fusion 360 can convert designs into technical drawings by turning it into a PDF file. Although students covered technical drawings in their Introduction to Engineering Design (IED) class, this is a great opportunity to review orthographic, top, front, and side views. I will emphasize dimensioning, so they can verify their designs later in the lesson. We will also learn how to export files into STL form as well, a requirement to 3D print. We will proceed to manufacture their prototypes using the SLA 3D printer, so each student will have their prototypes. Once the designs are manufactured, the second part of the lesson will be concluded. They will be able to hold in their hands something of their own creation.

Days 16-20

For the closing activity, students will work in pairs. We will explore the science of measurements, called metrology, which is vital in the manufacturing process. This is the reason for the emphasis on dimensioning when producing the technical drawings. I will first teach the class how to use dial calipers and micrometers by bringing and measuring everyday items such as Legos or plastic bottles. Each group will have to verify the dimensions of these items and confirm the findings with their partner. Once they grasp this concept I will have the students verify and compare the dimensions of their manufactured designs using these measuring instruments. Upon completing this lesson students should be able to create their working prototypes required in the EDD course.

To implement this lesson, I will need several items. First and foremost a SLA 3D printer. The Formlabs Form 2 SLA 3D Printer will be suitable for the courses I teach and, if possible, would like the RET team to acquire the 3D printer for us or facilitate it's acquisition with the manufacturer. I will also need for the Autodesk Fusion 360 software be installed in all the computers in my classroom as well as students having access to the software at home. Students need to work on their designs on a regular basis and these resources are essential. I will also need 20 standard dial calipers and 20 micrometers to complete the metrology part of the lesson. I would like the RET team to come talk to my students about opportunities and their experiences in manufacturing engineering. I will also need consumable supplies such as resin and periodical calibration and maintenance from my administration.

To close out the lesson we will have a group discussion to gather feedback. I will also be administrating an open-ended pre- and post-test to gage how much students learned. For this reason, I will administer the same test before and after the lesson. I expect much more elaborate answers after completing the lesson. The questions are as follows:

1. What is manufacturing engineering?
2. What is the difference between conventional manufacturing and 3D printing?
3. What experience do you have with CAD/CAM software?
4. What are some of the factors you should consider when CAM?
5. What can be 3D printed?
6. What cannot be 3D printed?
7. How does a lathe work?
8. What are the benefits of CAM?
9. What materials can be used to 3D print?
10. What makes 3D printing unique to other manufacturing techniques?

I truly believe students will enjoy and benefit greatly by completing this lesson. They will acquire new, valuable skills and have a better understanding of the engineering profession and essentially be better prepared when going to college and eventually entering the workforce.

The EDD curriculum requires students go through the engineering process to create a prototype as a solution to a problem. In the past, these have been constructed out of different materials such as metallic cups, filters, nets, water jugs, and PVC pipes donated by local businesses. With the skills acquired here at the RET program, and if provided the proper resources, my students will be able to construct these prototypes in class and diminish, or even eliminate, the need for assistance from third parties. These skills include technical drawing, metrology and CAD/CAM design. As part of the engineering process, modifications and adjustments must be made. If something does not look or work the way it was intended to, modifications are critical, however small these might be, to ensure a functioning product.

The RET program was a great experience and would recommend it to anyone. I have worked with some extraordinary individuals whom I have learned so much from and admire deeply. We explored many different topics, from designing drill bits to porosity and profilometry. Whether we realize it or not, everything is manufactured and there is much thought that goes into each design process. I will be implementing much of what I've learned, but there is an activity that stands out. A couple of times we were asked to research a topic, create a PowerPoint presentation and present it before the topic was even covered by the instructor. Once all group members had presented, the professor went on to give his lecture. This exercise gives one a better understanding of the material, a head start if you will, and serves as a reflection. This is a great exercise in a small group environment. I will be sharing my newly acquired skills with my students, but also with my administration and colleagues if given the opportunity.