



TEXAS A&M  
UNIVERSITY.



## Research Experiences for Teachers Enhancing Teacher Knowledge and Skills in Modern Manufacturing

TITLE: 3D Printing in the  
Sound Wave and Doppler  
Effect Lab  
By: JIN LU

Supported by: Yolanda Bruce  
Title: Principal  
School: James Madison High School  
Address: 13719 White Heather Dr,  
Houston, TX 77045  
Date: 07-15-2022



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By: JIN LU

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Supported by: Letra Johnican  
Title: Assistant Principal  
School: James Madison High School  
Address: 13719 White Heather Dr,  
Houston, TX 77045  
Date: 07-15-2022

A handwritten signature in black ink that reads "Letra Johnican".

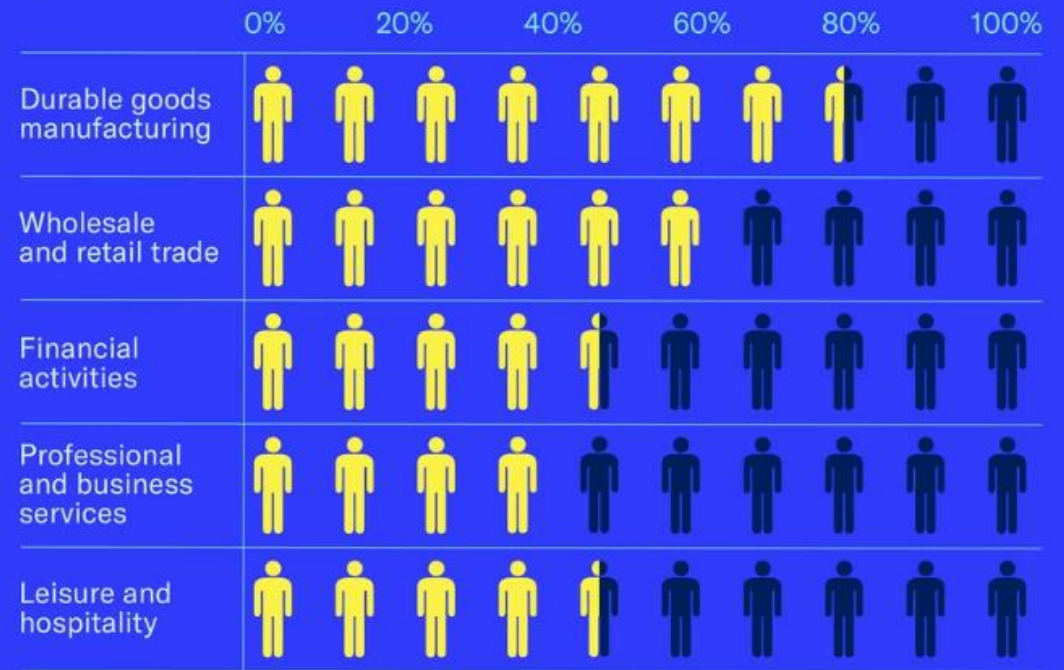
## Issue and Motivation

- ▶ The United States manufacturing industry is facing a severe shortage of skilled workers, losing roughly 1.4 million jobs. This results in a production gap, work outsourcing, and losing competitiveness in the market. Increasing student exposure to STEM-related lessons such as manufacturing and engineering will spark their interest in exploration and learning, resulting in better academic achievement and career development. Students majoring in the manufacturing field will eventually fill the shortage in the market.

## Labor Force Shortage by Industry



■ Unfilled job openings



Labor force participation for May 2022.

April JOLTS data was used.

Source: U.S. Chamber of Commerce Analysis, BLS Data

<https://www.uschamber.com/workforce/understanding-americas-labor-shortage-the-most-impacted-industries>

# Implementation

## 2 hours/week/class, 10<sup>th</sup>-12<sup>th</sup> grades

The issue students faced for topics such as the Doppler effect is the lack of hands-on experiments. Physics Education Technology (PhET) simulation was used in conjunction with lectures, due to the complexity of the concept students generally struggled to master the content.

By implementing the following elements:

- ▶ Design the various shape of whistles following the designing process.
- ▶ Use software such as Fusion 360 and Solid Work to create a CAD model, then print the 3D model of their designs.
- ▶ Inspect the model for accuracy in reference to the specs from the blueprint, then test for functionality.
- ▶ Based on feedback modification may apply, then it will be incorporated into the sound wave Doppler effect lab.

Students will have to take ownership of their learning, which will result in a higher participation rate and increased academic performance.

## Tentative schedule

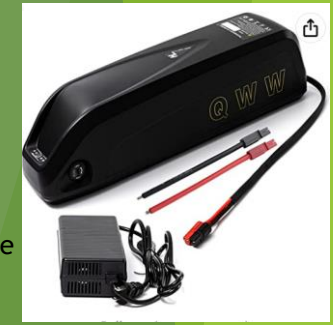
Fall of 2022 and Spring of 2023 school year.  
Thereafter while supported by the school.

# Equipment & budget

Quantity	Name	Unit Cost (\$)	Source URL
1	Dino lite digital microscope	400	Amazon ASIN: B099WLL1P5
1	CR 10 Smart Pro 3D printer	900	Amazon ASIN: B09PYSN2YJ
1	48V 10AH Lithium-ion Battery Pack	245	Amazon ASIN: B09C1Z3VKB
1	Electric Motor kit	200	Amazon ASIN: B099WLL1P5
5	PLA 3D printing filaments (Red, blue, black, white, grey)	100	Amazon ASIN: B09H7G1CS9
1	connectors, bolts, wire, etc.	100	
	Total	1945	



Dino lite digital microscope



48V 10AH Lithium-ion Battery Pack



Electric Motor kit



CR 10 Smart Pro 3D printer

Students will use a 3D printer and filament to construct a whistle. The electric motor kit, lithium-ion battery pack, and some 3D printed parts will be used to construct the electric scooter for the doppler effect lab.

# Assessment and Impact

- ▶ 25% increase in student participation in designing/engineering (about 160 students enrolled from the previous school year)
- ▶ Quiz/exam along with lab reports will be used to assess students' understanding of the concepts.
- ▶ Accurately produce a functional model from their design with proper dimensions
- ▶ Increase participation rate among Hispanic and African American student population, field trip TAMU and the University of Houston for more real-life application.

# Summary

- ▶ The biggest challenge in education is the lack of students' involvement. Students are unlikely to participate due to academic gaps or lack of interest in the content. Educators constantly try to come up with new ideas and approaches to gather students' attention and spark their interest. Students always enjoy hands-on activities, and always perform better academically.
- ▶ Constructing a whistle might be seeming simple. But creating their own design and 3D printing the model to be used in a lesson will increase students' participation by at least 25%. Expected student proficiency for this unit would grow at least 30 % compares to the previous year.
- ▶ 3D printing provides flexible design and rapid prototyping, it will have a drastic impact on the manufacturing and job market. Incorporating 3D printing in lessons will lay a foundation for our students for college and career choices.