# Integrating Sports into STEM Education

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## Abstract

The goal of our project is to create a sleeve that integrates STEM concepts with the game of basketball with the hopes of inspiring underprivileged students to pursue STEM fields. We are tasked with continuing the project from past semesters and collaborating with the Future Kings Mentorship program to continue to inspire underprivileged students. Our deliverables include a machine learning based shot classification system, a improved shot counter hardware, a sleeve with communication capacity, and a teaching plan layout containing engineering and basketball.

## Introduction

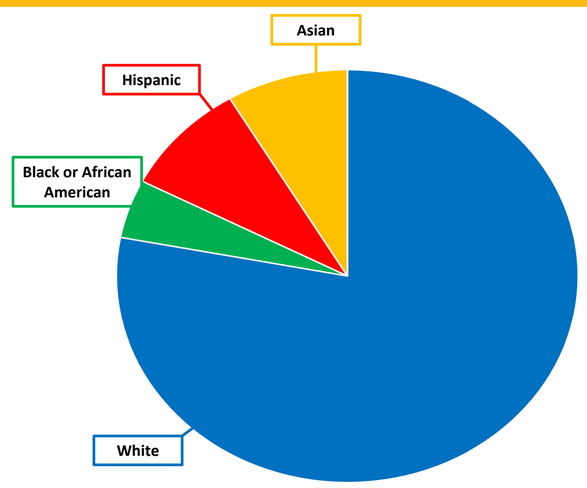



**Fig. 1**: STEM Race Representation

There is a lack of representation in STEM and mechanical engineering fields. Black or African American people make up only 9% of all people in the STEM field. For mechanical engineering, they only make up 4% of people in the field.

The lack of representation leads to products that have bias. The way to alleviate these issues is to inspire young underprivileged student to pursue a STEM career.

Our design project is to bridge the gap between black youth and their possible engineering career. It is a combination of STEM concepts, youth sports, and social justice. The importance of youth sports to the students allows for the cultivation of inspiration from the games they love.

We have partnered with Future Kings Mentoring. The program began with our sponsor, Terrell Galloway. Through the program, we hope to deliver a working sleeve system that can achieve the goals that we set for ourselves. The mentor program allows us to expose young black students to STEM ideas.

The anticipated work product—a fully functional basketball sleeve with integrated STEM learning capabilities—will serve as an educational bridge, engaging students in grades 6 through 12 in a hands-on STEM experience. The project will impact these students by providing them with the tools and knowledge to explore and understand the possibilities within STEM fields, particularly engineering, thus addressing the current demographic disparities.

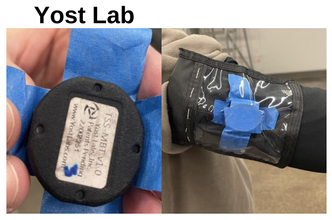
## Project Objectives

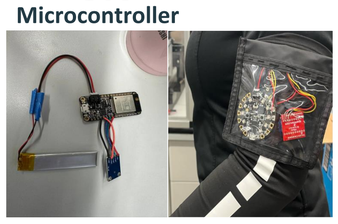
Objective 1: Improve Shot Counter: The shot counter switch arm apparatus needs to be designed to further strengthen the arm. This is the weakest part of the shot counter, where in previous prototypes, the switch arm kept breaking.
Objective 2: Determine Who Shot the Ball: The addition of determining who shot the ball will allow the kids to play with multiple sleeves. Machine learning will be used with accelerometers on the Playground Express to accomplish this goal.
Objective 3: Investigate changes to the boards used in the sleeves and goal counter: The Bluetooth signal of the current boards has a limited range. So it's needed to improve the sleeve to enhance its ability for wireless communication.
Objective 4: Integrating Sports into STEM education: Incorporate STEM elements into the game of Basketball to inspire underprivileged children to explore STEM.

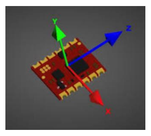
## Design Criteria

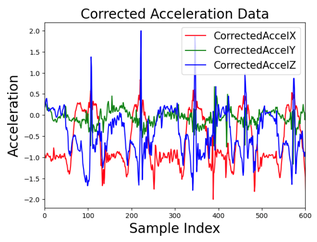
| Design Requirements | Specification | Validation Method |
|---|---|---|
| Durability and Safety | Zero safety incidents and a more durable shot counter | Force analysis on the system to determine magnet strength |
| Automatic Shot Classification | Attain 80% shooter identification accuracy. | A test sample data will used to determine the accuracy of the trained machine learning model |
| Integration of Basketball into Education | At least one-fifth of the teaching plan should involve actual experiments to make the teaching more interesting. | Draft an experiment teaching plan with different modules. Do some interviews for kids to get advice and review from them. |
| Wireless Communication | Achieve 100% coverage of the playground with less than 0.5% data transmission failure. | Do actual testing: measure the distance between the wireless connection and check the data is being correctly sent and read by code. |
| Sleeve Functionality | Reach a 70% user satisfaction rate regarding performance and data accuracy. | Wear the sleeve and justify the performance and functionality using vibration test |

## Design Process



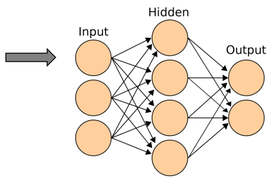



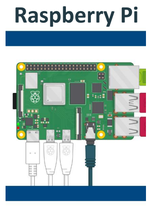




Input Data

Classification & Communication




The accuracy is **92.48%**




The scorekeeper is expected to be secure and durable, so we've improved the scorekeeper in these two aspects correspondingly as shown in the figures. In this process, we designed our model in Solidworks, and fabricated them out by 3D printer and the support from machine shop. As for educational designs, the conceptualized education modules are derived from our participation of STEM educational club.

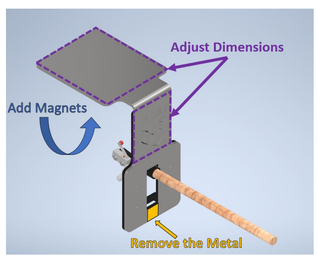



**Fig. 2:** Security Design

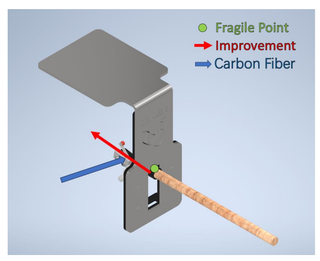



**Fig. 3:** Durability Design

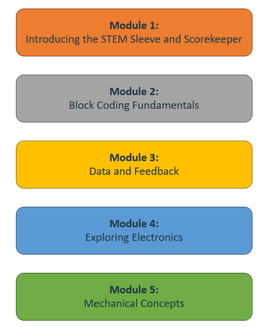



**Fig. 4:** Education Modules

## Validation

### Machine Learning Model

Our two machine learning models showed high levels of accuracy. The first model has an accuracy of 99%, while the second model has an accuracy of 92%.

```
val_loss, val_acc       = eval(model, test_loader)
print("\tVal Acc {:.04f}%\tVal Loss {:.04f}".format(val_acc*100, val_loss))
```

```
Index: 14, Prediction: passing, Label: shooting
        Val Acc 99.5833%        Val Loss 0.2128
```

**Fig. 5:** This model takes real time data and is only used when the shot counter detects a shot


**Fig. 6:** This model assumes data is loaded into the model once data is collected

### Shot Counter

Stronger magnets were used to secure the counter, with the magnet layout seen in Figure 7. Testing was done and the shot counter did not fall and was operating as expected for every shot.

**Fig. 7:** New magnet layout

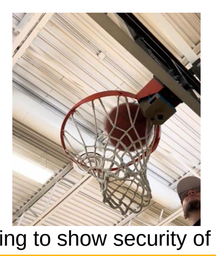


**Fig. 8:** Testing to show security of new design

## Discussion and Conclusions

Our project successfully integrated STEM concepts into the sport of basketball, addressing the underrepresentation of Black individuals in STEM fields by fostering greater interest among underprivileged students. Through the development of a machine learning-based shot classification system and the improvement of the shot counter hardware, we were able to create a more engaging and educational experience. The feedback from the implementation of our teaching plan highlights significant increases in student engagement and comprehension of STEM principles. The redesigned scorekeeper, using advanced materials and a robust design, met all durability and safety specifications, thereby enhancing the overall utility of the system.

The project's objectives were largely met, with the sleeve and scorekeeper system effectively demonstrating the integration of basketball and STEM education. While we achieved significant milestones in hardware improvement and educational engagement, the integration of wireless communication using Raspberry Pi remains incomplete. This aspect represents a crucial opportunity for future teams to enhance system connectivity and functionality.

## Acknowledgements

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