Virtual Gallery Walk of Capstone Projects

Culminating projects for Cecil County Public School Capstone Courses

Music: https://www.bensound.com
BOHEMIA MANOR HIGH
We recognize and congratulate these students from Bohemia Manor High School for completing their Capstone projects during extraordinary conditions.

**Honors Engineering**
**Design & Development**

Kira Osborne  
Danielle Woodie

**Honors STEM Research**
**& Design Capstone**

Matthew Ellis  
Grace Koerner  
Connor McGee  
Kelsey Meis
Title  
Engineering a Device Which Informs the User of Forgotten Personal Electronic Devices (PEDs)

Summary
Every year, thousands of Personal Electronic Devices (PEDs) are lost due to people forgetting their phones, laptops, computers, etc., and failing to retrieve them in time before they are stolen. Hermann Ebbinghaus showed in his Forgetting Curve that after only an hour, 51% of fresh information in the brain is remembered (Figure 1).

This project focused on implementing circuitry and C++ code to create a device a user could keep on them, connect to their PED (via Bluetooth), and be alerted to whenever their PED grew to be too far away from them in order to battle Ebbinghaus’ Forgetting Curve.

Design constraints required it to be small, easily portable, and durable to survive modern day activities. In order to accomplish this, advanced circuitry, such as the Arduino Uno and an RN42-Bluesmirf, were used to allow for code to be implemented into the circuit so it could complete this advanced function, all while maintaining a small size.

Initial construction was originally on a breadboard, but was later soldered together to reduce size. It was powered by a 9V battery and alerted the user through a vibration motor, which was powered once the connection between the device and the PED dropped. To test the device’s range you simply connected it to your PED via Bluetooth. After testing the circuit it was found that the range was 120 feet and that the device would function normally even if a minor physical obstruction, like a wall, was placed between it and the PED.

The final prototype was unsuccessful in notifying users of lost PEDs, so given more time the code would have been finalized and a case would have been created.
Engineering a Device Which Informs the User of Forgotten Personal Electronic Devices (PEDs)
Matthew Ellis
STEM Academy, Bohemia Manor High School

Abstract
Every year, thousands of Personal Electronic Devices (PEDs) are lost due to people forgetting their phones, laptops, computers, etc. and failing to retrieve them in time before they are stolen. Hermane Edinghaus explored this in his Forgetting Curve that after only an hour, 55% of fresh information in the brain is remembered (Figure 1). This project focused on implementing circuitry and C++ code to create a device a user could keep on them, connect to their PED (via Bluetooth), and be alerted to whenever their PED grew too far away from them in order to battle Edinghaus’ Forgetting Curve. Design constraints required it to be small, easily portable, and durable to survive modern day activities. In order to accomplish this, an advanced circuitry, such as the Arduino Uno and an RN-42 Bluetooth module needed to be used for the code to be implemented into the circuit so it could complete this advanced function, while maintaining a small size. Initial construction and assembly of the breadboard, but was later soldered together to reduce size. It was powered by a 9V battery and alerted the user through a vibration motor, which was powered once the connection between the device and the PED dropped. To test the device’s range you simply connected it to your PED via Bluetooth. After testing the circuit it was found that the range was 120 feet and that the device would function normally even if a minor physical obstruction, like a wall, was placed between it and the PED. The final prototype was unsuccessful in notifying users of lost PEDs, so given more time the code would have been finalized and a case would have been designed.

Problem Statement
The problem being addressed is how can one create a PED that can alert a user when they have forgotten an item. Overall forgetfulness is the direct cause of the problem, often people will leave behind these forgotten items where then can become susceptible to theft, environmental damage, and other unwanted effects. Anyone owning devices able to conduct Bluetooth connections, i.e. cell phones, laptop, and other electronics, and suffering from chronic forgetfulness in which they often leave behind these devices would benefit from a solution to this problem. The purpose of this proposed prototype is to prevent the initial forgetfulness that causes the losing of these devices. As the way it is able to do this is by alerting the user, through vibration, that their device is too far away from them, then realize their item is forgotten and retrieve it before unwanted effects can reach it. The proposed solution to the problem is to create a prototype circuit that is able to connect to electronic devices via Bluetooth so when the Bluetooth connection to another device is weak or powered off, the circuit will produce a vibration effect and alerting the user. The circuit will be made using a coin-magnet, an Arduino Uno Rev 3, a BlueSMRF bluetooth module, and a 9V battery with a connection module and will produce a solution to the prior mentioned problem.

Materials
- RN-42 BlueSMRF Arduino Uno Rev3
- 9V battery
- Coin Vibrating Motor
- Laptop access to Arduino IDE software
- 280Ω Resistor
- 4 Wires
- USB 2.0 Cable Type A/B
- Battery clip with DC Plug
- 6 Pin Headers
- Soldering Iron
- Spool of Solder

Constraints
- Size – needs to be as small as possible
- Range – needs to have a limit to where it won’t work anymore
- Budget – $100
- Time – roughly 3 months
- Damage – will be on person at all times, so needs to survive day to day activities

Methodology
The device was created with a breadboard shield so the device could be physically tinkered easily (Figure 2). The device was far too bulky after constructing it in this way, so once the wire locations were determined, the circuit was soldered in order to remove the breadboard and maximize size (Figure 4). Once the physical structure of the device was determined, then came time to use the laptop fitted with Arduino IDE software to begin programming the device with C++ code. Several sections of code were created that all accomplished small goals, such as powering the vibration motor, connecting to PEDs, and determining connection status. Due to unforeseen conditions the project was cut short ahead of schedule resulting in the final code (Figure 3) being incomplete. Provided there was the scheduled amount of time for the project the final steps would have included combining these code fragments into a final interfacing code, creating a case for the device to improve durability, and testing the device in range with various conditions being placed to observe if any change to range occurred.

Results
Although the final code of the device was incomplete, the device was still able to function in order to determine the range when there were no physical obstructions and when their were physical obstructions. It was found that physical obstruction did not affect the range and that the range was a consistent 120 feet

Further Discussions
Although the device was testable, it was unable to work as intended and complete the original problem statement created for this project. It was able to connect to PEDs, but failed to notify the user (through vibration from the vibration motor) when their PED was at too great a range. The next step for this project would be to create a protective case for it to remain in, so it wouldn’t get damaged through day to day use. Once that is completed the device would be able to combat the Forgetting Curve and help any number of people with protecting their valuable electronics (provided the code is fixed). The circuit allows the PED to be within 120 feet of the user before it powers the vibration motor and works through minor physical obstructions, such as walls. This project shows great potential for reducing the size of the device and becoming more portable, so future iterations could build off of this. Moreover this project shows that more can be done to help with memory loss and in the future more technology can be expected to help users prevent themselves from misplacing smaller sized PEDs. With further technology the device could get smaller and smaller and with any luck it may even be featured in a piece of apparel in order to minimize its dependence for user’s to remember to bring it with them.

Literature Cited

Acknowledgements
Mr. Jay Reynolds, President at UD
Title: **Measuring Bohemia Manor High School’s Carbon Emissions Through Electricity Usage, Water Usage, and Waste Production**

**Summary**

Climate change is occurring, and Earth is heating. If solutions are not implemented to curb the steady rise of carbon emissions in our world, habitats, animal life, and human populations will suffer. The purpose of this project was to find the average yearly carbon emissions of Bohemia Manor High School (BMHS) and then research solutions that would help BMHS (and schools everywhere) reduce emissions. Possible solutions were researched to decrease those emissions.

With final research, it was concluded that a solar farm (AZoCleantech, 2014) and a recycling program (Spake, 2012) for the school would be the most effective solutions in curbing BMHS’s emissions. From these findings, water usage data was incomplete and has been omitted.
Measuring Bohemia Manor High School’s Carbon Emissions Through Electricity Usage, Water Usage, and Waste Production

Grace Koerner
STEM, Bohemia Manor High School, Chesapeake City, Maryland 21915

Abstract
Climate change is occurring, and Earth is heating up (Climate Reality, 2020); therefore, we need to be aware of the steady rise of carbon emissions in our world. Carbon emissions are caused by the burning of fossil fuels, deforestation, and other human activities. The amount of carbon dioxide (CO₂) released into the atmosphere affects the temperature of the Earth, resulting in global warming and climate change. These changes can lead to sea-level rise, extreme weather events, and loss of biodiversity. The goal of this study is to evaluate Bohemia Manor High School’s (BMHS) carbon emissions and identify ways to reduce them.

Materials and methods
Testing BMHS’s Electricity Usage:
1. Inventory study: Three different devices were tested in three classrooms (left side) for the categories of low-end energy usage, mid-energy usage and high-energy usage. Smartboards, projectors, fans, and computer monitors were tested.
2. Using the Kill-a-Watt device (Figure 2), plug into a socket on a wall and then plug the device being tested into the Kill-a-Watt. After a day, the Kill-a-Watt will measure the kWh of the device.
3. Record the kWh of the device.
4. Repeat steps 2 and 3 six times per device per classroom.
5. Estimate the number of hours a day each device is used. Average the kWh of each device per day, then multiply by the number of hours it is used to get a daily reading.
6. Multiply the daily electricity usage by 180 (school days) to get the yearly electricity usage of each device.
7. Count the yearly electricity usage in carbon emissions with the carbon conversion rate for electricity for each device in each classroom.
8. Add the yearly carbon emissions of each device in each classroom to get each individual classroom’s carbon emissions.
9. Record each class’ average carbon electricity emissions for the school year.

Testing Waste Production (Classrooms):
1. Using gloves, collect the bags of trash in each trash can in each classroom a minimum of five times per classroom (Figure 3).
2. Using a scale, weigh each trash bag and record its weight (in pounds).
3. Add the total weight of each trash bag per classroom.
4. Average the total weight in each classroom per day, then multiply each class’ daily average by 180 (school days).
5. Count the yearly waste production of each classroom to carbon emissions with the carbon conversion rate for waste. Record each class’ average carbon waste emission for the school year.

Discussion
The study found that Bohemia Manor High School’s carbon emissions are high, with a significant portion coming from electricity usage. The school’s carbon footprint can be reduced by implementing energy-efficient practices, such as turning off lights and electronics when not in use, using energy-efficient lighting, and upgrading to more efficient appliances. Reducing waste production can also significantly lower the school’s carbon emissions, as waste incineration emits greenhouse gases. Recycling and composting initiatives can help divert waste from landfills, which are significant sources of carbon emissions.

Conclusions
From this study, despite water being emitted, final research was concluded to determine which is the most effective solution in decreasing emissions. Electricity usage was the biggest contributor to carbon emissions in the classrooms, so research revolved around ways to either decrease the overall electricity usage or ways to turn the usage into clean, renewable power. A solar farm (Figure 5), which produces as much electricity as the school requires, will be able to provide sustainable and reliable energy, thus reducing greenhouse gas emissions. This will not only save money but also create a cleaner environment for future generations. In addition, reducing waste production is another effective method to decrease carbon emissions. This can be achieved by implementing recycling and composting initiatives, as well as reducing waste generation through proper disposal and reuse of materials. Overall, the school can achieve significant reductions in carbon emissions by combining energy efficiency, renewable energy, and waste reduction strategies.
Title  The Highest Velocity Soccer Kick Based on a Foot’s Angle

Summary
Soccer is a fast pace, high intensity sport which requires you to think quick and act fast. The purpose of this research is to find out if changing the angle of your foot changes the velocity of a soccer ball and if it does, which angle produces the highest velocity ball.

The null hypothesis for this project was that there would be no change in the ball's velocity, regardless of the angle of a soccer player's foot when striking the ball.

The null hypothesis was determined to be false and the zero degree angle proved to have the highest velocity ball out of all of the angles tested.
The Highest Velocity Soccer Kick Based on a Foot’s Angle

Connor McGee

STEM Academy, Bohemia Manor High School, Chesapeake City, Maryland 21915

Abstract
Success in soccer relies on a high-intensity activity which requires you to think quick and act fast. With this in mind, it makes the most sense to know the fastest way to kick a ball to give it the highest speed possible. The purpose of this research is to find out how fast the angle of your foot changes the velocity of a soccer ball and if it does, which angle provides the highest velocity ball. The null hypothesis for this project was that there would be no change in the ball’s velocity regardless of the angle of a soccer player’s foot when striking the ball. With a pendulum that is shaped like a foot, this project was tested. The pendulum was placed on the turf field and angled based on an average foot’s resting position as the angle zero. Starting from the foot’s resting position, the angle is changed by 30 degrees up to 90 degrees. Each angle was tested a total of 20 times. By taking the distance that each ball traveled and how long it took for it to come to a full stop, it was found that the velocity of the ball would be averaged with every other trial for that angle to determine the total velocity for said angle. The null hypothesis was determined to be false and the zero degree angle proved to have the highest velocity ball out of all the angles tested.

Background
While you could just kick harder to change the speed, it would be best to know what conditions allow the ball to travel faster. With this in mind, I decided to try changing the angle of a person’s foot to see if the effect it would have on the ball’s velocity. There’s only so far that a person can naturally turn their foot without causing damage to their bodies. With this constraint, the angle had to be within 90 degrees to keep the testing safe. The “proper” way to kick a soccer ball is to have your leg parallel to your hip which is actually would be the 90 degree angle.

Materials
The materials for this project include: a mannequin leg, 3 8 foot 2x4's, 6 box of screws, wood glue, wood wax, 2 washers, a bolt, 3 nuts, a 50 centimeter dowel rod, a 50 centimeter by 50 centimeter base board a cleat, a soccer sock, a mallet stick, a video recording device, and a soccer ball.

Methods
To conduct this experiment, the pendulum leg was brought out to the turf field and placed on the zero yard line (to help with reference). The ball would then be placed in the small, shallow hole in the baseboard. The leg would be adjusted to whatever angle was necessary (in the starting case, this would be angle zero), then the leg would be pulled back to the desired angle and released. Another person would be recording this in one fluid motion without breaking the ball. The videos were used to determine the time it took for the ball to stop. Then, using a mallet stick, the researcher would measure from the origin point of the ball to where it stopped. Then, rise and repeat for a total of twenty trials per angle.

Hypothesis
H1: There will be no change in velocity between the angles.

H2: There will be a change in velocity depending on how you angle your foot.

Results
The results from this data was that the zero degree angle created the highest velocity kick as shown from the data below. The 30 degree angle proved to be the slowest kick of all. One note that should be known is the 90 degree angle was tested in a different place than the rest of the angles due to the COVID-19 outbreak which means the numbers could have turned out different. Further testing would need to be done to give a distinct answer to this proposal. Another note that should be made is, originally the goal of each trial would have been used with Loggar Pro to create a graph of the data but this was scrapped due to the events of COVID-19. The videos were used to determine how long it took for the ball to completely stop moving. There was a pattern in the data between the 30, 60, and 90 degree angle with a slight increase. The confusion from this data came from the zero degree. When retaking the recordings I notice only one big difference from the rest. In the zero degree the ball was kicked into the air. Since the ball was knocked into the air it had to stop bouncing before it could slow down. This is the only thing that the researcher could see that would have caused it to not only go further but it to have a more sporadic set of data compared to the rest of the angles.

Conclusion
From this data I have learned that angling your foot has an effect on the velocity of a soccer ball. An observation that I made while conducting this research was the ball went from relatively accurate to the sidelines of the turf field with the zero degree, to not at all accurate with the 30 and 60 degree angles and went back to accurately again with the 90 degree. Further research would need to be done to be determined.

Special Thanks
I would like to thank Matthew Jordan, Matthew Ellis and Grace Koerner for helping with the recordings. I’d like to thank my mentors Dr. Hendrik Reimann and Ms. Nicole McIver for guiding me throughout this experience. Last but not least, I would like to thank my teacher, Jacob Zakai, and the STEM Academy for giving me the opportunity to conduct this research.

Citations

Further Information
Please contact connormcgee251089@gmail.com for further information about this project.
Title  
Testing the effect of ingredients in plant-based yogurts on bacterial production of vitamin B12

Summary  
Vitamin B12, vital to brain and immune health, is produced by certain bacteria strains.

This experiment sought to create a cost-effective plant-based source of B12 from millet, hemp, soy, and cashew yogurts. The possibility remained that these yogurts would not yield B12, or that the amount would not vary between samples.

The test results showed no discernable amount of B12 in any of the four samples, so the null hypothesis was not rejected.

So while this experiment did not produce a plant-based source of B12, the process could be reevaluated so future batches are more conducive to B12 production.
Testing the effect of ingredients in plant-based yogurts on production of vitamin B12

Kelsey Meis
STEM Academy, Bohemia Manor High School

Abstract

Vitamin B12, vital to brain and immune health, is produced by certain bacteria found naturally in the bodies of water, and feces; B12-producing bacteria are kept from harm by general public in developed countries thanks to modern sanitation, water filtration, and waste disposal (Koplewicz, 2020). While B12-deficiency is rare, and thus can provide adequate dietary B12, individuals that avoid animal products for ethical, environmental, or health reasons can struggle to meet their recommended daily intake. This experiment sought to create a core-effective plant-based source of B12 from milks, hemp, soy, and cashew yogurts. The possibility remained that the amount of B12 would not yield B12, or that the amount would vary between samples, which the null hypothesis acknowledged. An alternative hypothesis predicted a higher B12 yield among high-carbohydrate ingredients over fats to provide simple sugars would allow the B12-producing bacteria in the culture to synthesize at a greater rate. The methodology consisted of making the plant milks, adding vegan yogurt starter culture, and fermenting in an Instant Pot pressure cooker (Figures 1-3). The samples were carefully packaged and sent to a EUROBIOTICS lab to be professionally tested for B12. The test results showed no discernible amount of B12 in any of the four samples (0.05 to 0.15 pg/mL), so the null hypothesis was not rejected. Low inoculation temperature and week starter cultures likely limited production (Kuhlmeier, 2013). So while this experiment did not produce a plant-based source of B12, the process could be reevaluated as future batches are more conducive to B12 production.

Background Information

Vitamin B12 - Produced by Bacteria found in soil, bodies of water, digestive tracts
- Santonin and Sulfation of fat and water
- Need 2-4 mg per day for adults
- Holos DNA, Red Blood Cells, Immune, Brain Function

We need more vegan options to promote individual, planetary, animal well being.

Experiment applications include:
- The possibility of using the Mother Culture (precious batch) as a starter culture for sheep's milk, sustainable B12 source
- Prevent B12 deficiencies (vagans and non-vagans!)

Hypotheses

H0: B12 production will not be affected by the ingredients
H1: Ingredients with a higher carbohydrate composition (milks) will have a positive effect on the B12 content of the plant-based yogurt

Materials

This plant-based yogurt recipe is entirely edible and consumer-friendly. It is high in fiber and water and does not contain any added sugar, salt, oil, or preservatives. The recipe materials were obtained below:

- 1 cup base ingredient:
  - plant milks, milk, hemp hearts, flaxseeds, dry soy beans
- 2 gels 4-6 caps: maca, 4, 4-6 meal: jas, kala
- metal spoon and fork/whisk (using four different ones)
- immersion blender (could transfer to traditional blender)
- metal strainers/vee, cheese/batte/bandana
- rubber band
- instant pot/slow cooker (could culture it in even)

This yogurt recipe and process is a culmination of those from websites VeganVegan Live, MinimBli Bakes, and Compost Vegetarian Kitchen, as well as the directions on the Cultures For Health Vegan Yogurt Starter Culture packet.

Methods

Vegan Yogurt:
- Rinse 1 cup of each ingredient (cashew, coconut, hemp, flax, soya), mix 1/2 cup of water for 5 hours, drain
- Transfer to milk bowl, add 1 cup water, and blend to a cream using an immersion blender
- Place cheesecloth over another bowl, white strainer over cheesecloth
- Pour blended material through straining system, allowing liquid to drain, using metal spoon to press material through strainer
- Remove white strainer, squeeze out remaining liquid from cheesecloth
- Transfer plant milk to saucepan, heat 82°C for 15 minutes, stirring occasionally, remove card skin that may form on top
- While milk is heating, stereotaxing jars in a 400°F Even (369°C) for 10 minutes
- Pour hot plant milk into sterilized jars, wait until the plant milk reaches 42°C then stir in 1/5 tsp Vegan Yogurt Starter Culture (too tight for the kitchen scale detector)
- Let mason jars 10 hours in 42°C Instant Pot on slow cooker setting

Jars were plastic wrapped and cushioned in the shipping box sent through the USPS to the lab. At EUROBIOTICS, technicians perform HPLC (High-performance liquid chromatography) and microbiological testing for vitamin B12 analysis. The first is a method of separation, identifying, and measuring the amount of a chemical in a substance through the use of solvents and absorbent materials. The second is designed to test for the presence of microorganisms in a sample.

Visual Methodology

Figure 1: The image to the right shows the squeezing ingredients

Figure 2: The image to the left displays the blending process of the cooked milk using an immersion blender.

Figure 3: The right image shows the straining system, pushing the blended material through the wire mesh.

Figure 4: The left image is of the squeezing of the cheese cloth.

Results and Analysis

The EUROBIOTICS analysis showed that all four yogurt samples were below 1 pg/mL at 100 pg/mL. No low inoculation temperature or week starter culture could have interfered with B12 production by not allowing bacteria to ferment the yogurts (Mueller, 2015). No discernable amount of B12 was found in the samples, and this is likely due to inadequate temperature regulation during the inoculation process. If the temperature was too cold, the bacteria will not properly ferment the sample, and not convert sugars into lacto and vitamin B12. The consistency of the starter culture packet instructed the use of 1 packet per liter of yogurt. After running the tests shown in Figure 5, it was determined that 1/8 tsp, should be used for the 4 oz. samples. It is possible that the small amounts of culture that was mixed into each sample was too miniscule or week to make an impact (Mueller, 2015). The lab results indicated no discernable B12 in the yogurts samples, thus the experiment failed to reject or null hypothesis.

Conclusions

So while this experiment did not produce a plant-based source of B12, the process could be reevaluated as future batches are more conducive to B12 production. Using temperatures probe in the future to monitor the yogurt inoculation or making larger batches with more starter culture in future experiments could provide the bacteria with the necessary condition to produce B12 in these plant-based yogurts.

Citations


Acknowledgments

Ms. Christine Warwick, Professor of Biotech, Cecil College
For unsavory support, guidance, and understanding throughout the unique school year as the student's mentor.
Additional thanks to Mr. Jacob ZinkInd, Ms. Christine ZinkInd, and Ms. Frances J. Curtis of Cecil CCEP.
For never ceasing to ask the important questions.

For Further Information

Please contact Kelsey at kelseym181116@cvcc.org for more information about the project.
Title  Horse Bit Warmer

Summary
Leaving a horse’s bit in the barn during the cold months leads to increased tack up time and an uncooperative horse before and during riding. An uncooperative horse leads to lost riding time due to having to deal with bad behavior such as raising of the head to avoid the cold bit. Many riders, especially shorter ones, struggle to reach their horse’s raised head, making it impossible to put on the bridle until the horse lowers their head.

Goal was to create a fabric, detachable bit warming tool that heats up in only 15 minutes and does not exceed the desired temperature. After reaching the desired temperature, it will shut off for fire precautions. Not only will it heat both the mouthpiece and the rings, it will vary in size and style per different bit styles.

Analysis was not completed given the school closing.
Horse Bit Warmer
Danielle Woodie & Kira Osborne
Honors Engineering Design and Development, Bohemia Manor High School

Problem Statement:
Leaving a horse’s bit in the barn during the cold months leads to increased tack up time and an uncooperative horse before and during riding. An uncooperative horse leads to lost riding time due to having to deal with bad behavior such as raising of the head to avoid the cold bit. Many riders, especially shorter ones, struggle to reach their horse’s raised head, making it impossible to put on the bridle until the horse lowers their head.

Background Knowledge:
A horse bit is a piece of material placed in the horse’s mouth used to steer, slow, and stop a horse.

Viability Of Problem:
- Most barns aren’t heated in the winter, causing bits to become uncomfortably cold for horses
- Repeatedly putting a cold bit in a horse’s mouth can lead to behavioral problems that increase tack up time and decrease rider safety
- If a bit is still an uncomfortable temperature for the horse during riding, they are less likely to be cooperative to your given cues

Solution:
Create a fabric, detachable bit warming tool that heats up in only 15 minutes and does not exceed the desired temperature. After reaching the desired temperature, it will shut off for fire precautions. Not only will it heat both the mouthpiece and the rings, it will vary in size and style per different bit styles.

Prototype:

Analysis:
We ended up with nothing to analyze given the school closing.

Acknowledgements:
Thank you Mr. Spencer for helping us brainstorm ideas and solutions as well as for assisting us throughout the entire design process. Thank you Mr. Zimmerman, our classmates, and all the others who provided valuable feedback on our midterm presentations.

Idea:
- Create a pouch that the horse bit would slide into, heating it
- Use hot water pouch that the horse bit would sit inside of but not get wet
- Use thick, soft material to wrap the bit in to warm the area

Testing:
Due to the school closing, we were not able to do much testing. In terms of testing, we were planning on wrapping various bits in a heating blanket to get a good idea of what temperature we would need to maintain in order to heat the bits in 15 minutes or less.

Conclusion:
At this point in time, we had hoped to be in the final stages of testing our finished design. Unfortunately, the school year being cut short has prohibited us from getting to that point.
Title  Horse Bit Warmer

Summary
Leaving a horse’s bit in the barn during the cold months leads to increased tack up time and an uncooperative horse before and during riding. An uncooperative horse leads to lost riding time due to having to deal with bad behavior such as raising of the head to avoid the cold bit. Many riders, especially shorter ones, struggle to reach their horse’s raised head, making it impossible to put on the bridle until the horse lowers their head.

Goal was to create a fabric, detachable bit warming tool that heats up in only 15 minutes and does not exceed the desired temperature. After reaching the desired temperature, it will shut off for fire precautions. Not only will it heat both the mouthpiece and the rings, it will vary in size and style per different bit styles.

Analysis was not completed given the school closing.
Horse Bit Warmer
Danielle Woodie & Kira Osborne
Honors Engineering Design and Development, Bohemia Manor High School

Problem Statement:
Leaving a horse’s bit in the barn during the cold months leads to increased tack up time and an uncooperative horse before and during riding. An uncooperative horse leads to lost riding time due to having to deal with bad behavior such as raising of the head to avoid the cold bit. Many riders, especially shorter ones, struggle to reach their horse’s raised head, making it impossible to put on the bridle until the horse lowers their head.

Background Knowledge:
A horse bit is a piece of material placed in the horse’s mouth used to steer, slow, and stop a horse.

Viability Of Problem:
- Most barns aren’t heated in the winter, causing bits to become uncomfortably cold for horses
- Repeatedly putting a cold bit in a horse’s mouth can lead to behavioral problems that increase tack up time and decrease rider safety
- If a bit is still an uncomfortable temperature for the horse during riding, they are less likely to be cooperative to your given ques

Solution:
Create a fabric, detachable bit warming tool that heats up in only 15 minutes and does not exceed the desired temperature. After reaching the desired temperature, it will shut off for fire precautions. Not only will it heat both the mouthpiece and the rings, it will vary in size and style per different bit styles.

Prototype:

Testing:
Due to the school closing, we were not able to do much testing. In terms of testing, we were planning on wrapping various bits in a heating blanket to get a good idea of what temperature we would need to maintain in order to heat the bits in 15 minutes or less.

Conclusion:
At this point in time, we had hoped to be in the final stages of testing our finished design. Unfortunately, the school year being cut short has prohibited us from getting to that point.

Analysis:
We ended up with nothing to analyze given the school closing.

Acknowledgements:
Thank you Mr. Spencer for helping us brainstorm ideas and solutions as well as for assisting us throughout the entire design process. Thank you Mr. Zimmerman, our classmates, and all the others who provided valuable feedback on our midterm presentations.
We recognize and congratulate these students from Elkton High School for completing their Capstone projects during extraordinary conditions.

**Honors Education Academy**
Sidney Caldwell
Ivan Galindez

**Honors Homeland Security Capstone**
Cierra Davisson
Annalise Swain

**Honors STEM Research & Design Capstone**
Reese Berry
Riley Brady
Austin Caricofe
Ava Cox
Edward Dalrymple
Ciara Hopkins
Ryan Knight
Cameron Michalak
Samuel Teigland

**Honors Engineering Design & Development**
Ethan Kirk
Title Designing an Eco-Friendly Surfboard from Bio-Based Materials

Summary
Many surfboards currently are the complete opposite of being what would be considered “eco-friendly.” Traditional surfboards are made up of materials such as non-biodegradable polyurethane foam, and highly toxic epoxy resin.

The process of putting all the pieces of the surfboard together takes many raw materials such as oil to make, and the carbon emissions released during the construction is too high.

This study will find eco-friendly materials that will replace the current standing materials in surfboards, to make a new surfboard that is recyclable and non-harmful towards the environment. Research was conducted on the following topics: construction of boards, current eco-friendly surf companies, and materials.
Designing an Eco-Friendly Surfboard from Bio-Based Materials
Reece Berry
Elkton High School

Abstract

Many people overlook surfboards as being anywhere near toxic and polluting; however, many surfboards currently are the complete opposite of being what would be considered "eco-friendly." Traditional surfboards are made up of materials such as the non-biodegradable polyurethane foam, and the highly toxic epoxy resin. The process of putting all the pieces of the surfboard together takes many raw materials such as oil to make, and the carbon emissions released during the construction is utterly too high. This study will find eco-friendly materials that will replace the current standing materials in surfboards, to make a new surfboard that is recyclable and non-harmful towards the environment. Research was conducted on the following topic: construction of boards, current eco-friendly surf companies, and materials.

BACKGROUND

Within the world of surfing there are a variety of surfboards, constructed in all different shapes, sizes, materials, and brands. The majority of traditional boards are made up of the same surfboard blank, polyurethane foam, and then coated in epoxy resin. However, there is a widely unknown problem in surfing, which is the polyurethane in surfboards is actually highly toxic material and non-biodegradable. Therefore when boards are placed in landfills, they will never biodegrade and landfills will just continue to grow, resulting in pollution. A study from nScience Direct showed that under anaerobic conditions, polyurethane foam failed to biodegrade, showing no change in tensile strength or weight. The epoxy resin of boards is also highly toxic and is usually overused by surf companies. The carbon emissions released and natural resources used during the construction of a board is absurdly high and is very harmful to the Earth’s atmosphere. According to Surf Science, the construction of surfboards yearly produces about 220,000 tons of carbon emissions, which can compare to the carbon emissions.

MATERIALS AND METHODS

The engineering of this board will be a straightforward construction process, as all boards are built through taking the same steps. The only difference will be the materials used in the building process.

Steps
1.) The dimensions of the board will be found. The mold will only be a miniature version but the dimensions will be in direct proportion to the dimensions of a regular sized board.
2.) The boards blank will be cut out using a saw. This blank is typically the polyurethane foam, but in this case a bio-based alternative.
3.) The blank will be split through the middle down the long way.
4.) The two halves will be connected by a wooden stringer.
5.) An electric planer will be taken to the board to remove the outer hard layer of the board and any extra chunks of materials that are unneeded.
6.) The board will then be sanded down to finalize the initial shape.
7.) A sheet of a fiberglass alternative will then cover the board. This will specifically be either a sheet of hemp glass or bamboo, both very eco-friendly.
8.) The board will then be covered in a bio-based epoxy resin. This will be applied very carefully in order to reduce carbon emissions.
9.) The board will be sanded again once hardened.
10.) The board will once again be covered in a bio-based epoxy to give the board a glossy finish.
11.) The board will be sanded one last time to finalize its design.

RESULTS

REFERENCES

Acknowledgements

I would like to thank Mrs. Sikula (my teacher), Michael Vincelli (mentor), Ms. Hipka (teacher), Mr. Smother (teacher), and my father for the help and guidance through my project.

STEM HIGH SCHOOL
Title  Comparing Strength of Eco-Friendly Flooring Materials to Other Common Wood Floorings

Summary
Many different types of floorings are used in the construction of houses, but most are not eco-friendly.

The purpose of this project is to test the durability of eco-friendly materials of bamboo and teak and compare them to common wood floorings that are not eco-friendly.

The study was conducted by sizing all the materials the same width and length and then testing their strength in the Vernier Material tester. The project results proved that the eco-friendly bamboo and teak were just as durable and better than the other common wood floorings.
Comparing Strength of Eco-Friendly Flooring Materials to Other Common Wood Floorings

Riley Brady, Elton High School, Grade 11

Abstract

Many different types of floorings are used in the construction of houses, but most are not eco-friendly. The purpose of this project is to test the durability of eco-friendly materials of bamboo and teak and compare them to common wood floorings that are not eco-friendly. The study was conducted by sizing all the materials the same width and length and then testing their strength in the Vernier Material Tester. The project results prove that the eco-friendly bamboo and teak were just as durable and better than the other common wood floorings.

Methods

Obtain all materials (wooden harvest, teak, bamboo, aged hickory, hickory country natural, and plano oak). Cut all the materials the same length and width (Length - 3.5 inches, width - 1 inch). 3 of each material. Setup and connect LoggerPro to the materials tester to collect data. Move the test left and right crossbar where the edge is on four inches. Place the first material, teak, on top the crossbars horizontally. Attach the U-bolt chain around the material. Zero the displacement and Force sensors. Begin turning the displacement wheel to 1000 N. Detach the chain from the material and repeat 1-6 for the rest of the materials 3 times each. The LoggerPro connected to the materials tester will be collecting data in force in Newtons and displacement in centimeters. Analyze what damage and record the observations of what was done to the materials after 1000 N of force applied. Log all of the results.

Data

<table>
<thead>
<tr>
<th>Material</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bamboo</td>
<td>Remained unbroken to max of 1000 Ns</td>
<td>Remained unbroken to max of 1000 Ns</td>
<td>Remained unbroken to max of 1000 Ns</td>
</tr>
<tr>
<td>Teak</td>
<td>Remained unbroken to max of 1000 Ns</td>
<td>Remained unbroken to max of 1000 Ns</td>
<td>Remained unbroken to max of 1000 Ns</td>
</tr>
<tr>
<td>Wooden harvest</td>
<td>Remained unbroken to max of 1000 Ns</td>
<td>Remained unbroken to max of 1000 Ns</td>
<td>Remained unbroken to max of 1000 Ns</td>
</tr>
<tr>
<td>Aged hickory</td>
<td>Cracked at 805.6 N and broke at 903.5 N</td>
<td>Cracked at 802.7 N and broke at 904.2 N</td>
<td>Cracked at 804.5 N and broke at 903.9 N</td>
</tr>
<tr>
<td>Hickory country natural</td>
<td>Broke at 823.3 N</td>
<td>Broke at 825.6 N</td>
<td>Broke at 826.8 N</td>
</tr>
<tr>
<td>Plano oak</td>
<td>Broke at 862.5 N</td>
<td>Broke at 859.0 N</td>
<td>Broke at 861.2 N</td>
</tr>
</tbody>
</table>

Results

All of the materials were tested up to 1000 Ns (max range for the Vernier tester), but each material had different results. The teak and wooden harvest held up the best and was able to withstand all 1000 Newtons of force. The bamboo was a close competitor to the teak and wooden harvest but had bigger damage than the two. The aged hickory and hickory country natural were the weakest followed by the plano oak, which all broke. The Two-Way ANOVA test provided the p-value of 0.0047368 which is lower than 0.05, meaning the null hypothesis was rejected.

Conclusions

Since the p-value is lower than five percent and the null hypothesis was rejected, the eco-friendly materials held up better than the non-eco-friendly materials. With the rejection of the null hypothesis, it is suggested that with further testing eco-friendly materials can be shown to be as strong as common wood floorings that are not eco-friendly. Although the teak was the least damaged along with the wooden harvest, the bamboo was closely behind the two with minimal damage. In hindsight measuring the size of the cracks and other damage should be considered. A question that will be asked is “are eco-friendly materials just as durable, then why are they not used more?” The answer to that question is that they are more expensive and exotic than common wood floorings that are not eco-friendly. Bias and errors were attempted to be avoided, but the project is not perfect. During the cutting of the materials, the thickness could not be changed due to the structural integrity of each material. Also, when the materials are used in floors, the thickness that was used is the common thickness used when constructing the floors. Thus, altering the thickness of the materials would change the real identity of the floorings. In order to make the materials not so expensive, light wood be chosen on the eco-friendly materials to be used more. This will make the eco-friendly materials more common.
Sidney Caldwell
Grade 12
Elkton High School

Title Teacher Academy of Maryland
The Show Must Go On

Summary
Student will be able to complete a rigorous, college-level program that is based on the outcomes of the Maryland Associate of Arts in Teaching (A.A.T) degree, which aligns with the National Council for the Accreditation for Teacher Education (NCATE) standards by exploring Human Growth and Development, Teaching as a Profession, Foundations of Curriculum and Instruction and participating in an Education Academy Internship in a CCPS school.
Teacher Academy of Maryland
Sidney Caldwell
Elkton High School

Topic: The Show Must Go On

Cecil County School of Technology
Class of 2020

Closure:
Upon my completion of the TAM program, I will first work as a paraprofessional in a school system to acquire more experience and knowledge in this field of working. If I enjoy working as a paraprofessional, I will then attend Delaware Technical Community College to further my education in becoming a teacher. After attending Delaware Technical Community College for two years, I will transfer to Wilmington University to finish bachelors degree in Elementary Education. From the experience of being in the TAM program, I want to still become a teacher to educate and make a difference in children’s lives.

Assessment:
I believe that I learned how to be professional in TAM. I learned that I am a caring, compassionate leader and team mate who is ready to help. In TAM I felt as if I had a sense of belonging. Even in difficult situations, I learned that when you take your time to think anything is possible. I have learned to be adaptable to new environments. When working with others, I realized that there are some personalities that make it hard for others to work together, however, each member has to play their part in order to be successful. When I first entered the TAM program, I did not know what to expect. But this experience gave me great joy for the past two school years. I enjoyed working with my peers and made memories that I will never forget. Being in TAM was a great opportunity that I will never take for granted.

Homework:
Attend Delaware Technical Community College to major in Elementary Education

Apply for a job as a paraprofessional then as Kindergarten Teacher

Future Goals: To be happy with my work and to live a peaceful life

Acknowledgments:
Kelly Eddinger - TAM Instructor
My Parents
Session 3 TAM
Sandra Borns - EHS Counselor
Jennifer Bird - CCST Counselor
Title  Improving Headgear Used in Soccer

Summary
Headgear is commonly used in youth leagues for soccer. It is used to help protect against a worldwide problem that can cause everlasting effects in concussions. This project is to test to see if a highly rated piece of headgear, the Storelli Exoshield, can be improved to decrease force to the head.

After testing, the improvement was shown with great extent as the force was dropped 15-18 newtons. This shows just how easy it is to improve the headgear.

Although the companies making headgear cannot claim their product protects their users from concussions, they can say that they decrease the force the head is subject to; This will in turn help the head in the long run.
**Background**

Headgear is commonly used in youth leagues of soccer all around the world, although primarily in the United States. Headgear is used to help protect against a worldwide problem that can cause everlasting effects in concussions. This project is to test to see if a highly rated piece of headgear, the Stellix Exoshield, can be improved to decrease force the head will face. A pendulum was made using wood, metal and percussion over a skull with the headgear and accelerometer. After getting the base group completed, FlexTech Foam was added to test if it would help the headgear in decreasing the force the head is subject to. A 5 pound weight was then swung onto the forehead and back of the head and then measured using the force or peak acceleration. After testing, the improvement was shown with great extent as the force was dropped 15-18 newtons. This shows just how easy it is to improve the headgear. Although the companies making headgear cannot claim their product protects their users from concussions, they can say that they decrease the force the head is subject too. This will in turn help the head in the long run.

**Methods**

The independent variable of this investigation was the Stellix Exoshield Head Gear that was tested on a mannequin head, and the dependent variable was the amount of force that the head is subject to. A constant of this was the testing process used on the head after each change/addition, and the amount of material that is added to the headgear (1/8th inch in diameter). The control group for this investigation will be the mannequin head with only the Stellix Exoshield Head Gear on it. The control group is important because it created a baseline for the whole experiment. The control groups helped to determine the effectiveness of the headgear and the additional materials.

To increase the accuracy of the data and to remove error there were 60 trials and the procedure was repeated exactly the same each time. This helped make sure that the results were accurate. Some challenges that may occur are passing referee inspection, making sure the weight inflicted enough force to cause a concussion, and even placing the accelerometer in the head gear. As far as my research and personal knowledge show, the helmet should meet all requirements by FIFA and almost all other levels of soccer. I had to keep the helmet small and soft to allow it to pass inspection. The weight was used because of my inability to find a way to fire a soccer ball at the head at a great enough speed. The weight weighs about 5 times more than a soccer ball, meaning it can move at a much slower speed and cause the same amount of force. After getting the results we find that the weight did in fact put enough force on the head to possibly cause a concussion.

**Results**

<table>
<thead>
<tr>
<th>Trial</th>
<th>No foam back</th>
<th>No foam front</th>
<th>1/10th in foam back</th>
<th>1/10th in foam front</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>33.51</td>
<td>29.95</td>
<td>23.5</td>
<td>22.41</td>
</tr>
<tr>
<td>2</td>
<td>29.58</td>
<td>29.34</td>
<td>25.08</td>
<td>21.71</td>
</tr>
<tr>
<td>3</td>
<td>34.67</td>
<td>28.78</td>
<td>24.34</td>
<td>22.03</td>
</tr>
<tr>
<td>4</td>
<td>33.52</td>
<td>29.34</td>
<td>23.78</td>
<td>21.11</td>
</tr>
<tr>
<td>5</td>
<td>29.86</td>
<td>29.96</td>
<td>23.84</td>
<td>22.59</td>
</tr>
<tr>
<td>6</td>
<td>31.65</td>
<td>28.28</td>
<td>24.45</td>
<td>22.88</td>
</tr>
<tr>
<td>7</td>
<td>32.65</td>
<td>29.12</td>
<td>23.75</td>
<td>22.46</td>
</tr>
<tr>
<td>8</td>
<td>30.84</td>
<td>28.7</td>
<td>24.24</td>
<td>21.97</td>
</tr>
<tr>
<td>9</td>
<td>31.56</td>
<td>28.91</td>
<td>24.38</td>
<td>21.82</td>
</tr>
<tr>
<td>10</td>
<td>33.54</td>
<td>27.89</td>
<td>23.23</td>
<td>22.28</td>
</tr>
<tr>
<td>11</td>
<td>32.43</td>
<td>29.78</td>
<td>23.87</td>
<td>22.59</td>
</tr>
<tr>
<td>12</td>
<td>31.75</td>
<td>29.49</td>
<td>24.01</td>
<td>21.93</td>
</tr>
<tr>
<td>13</td>
<td>30.8</td>
<td>28.31</td>
<td>23.73</td>
<td>21.16</td>
</tr>
<tr>
<td>14</td>
<td>32.24</td>
<td>28.92</td>
<td>24.42</td>
<td>22.6</td>
</tr>
</tbody>
</table>

Ave. Acceleration 32.0964 29.0128971 24.0735714 22.11
Average Force 72.725 65.7999994 54.5978970 50.1445956

**Discussion**

With the conclusion of the testing, it has become rather obvious that headgear used in soccer can indeed be renovated and improved to better protect against force the head may face. With just the addition of an eighth of an inch of foam which is not commonly used in headgear, the change in acceleration/force on the head was drastic. With a little more time and access to materials, a comparison of materials would be a good action to take next. Although the use of headgear is not very popular in the sport of soccer, many rules are being put into place forcing young children to wear headgear until a certain age (varies but usually around age 11). Due to rules like this becoming more popular and widespread, parents should have access to the best headgear they can get their hands on, while remaining affordable. This experiment shows just how easy it can be to improve the headgear to better protect one’s head and brain. With more time the ability to improve the headgear while keeping it the same size would become possible. The only problem with adding more material is that it becomes more bulky. That can affect how one plays their game, so keeping it small and soft is important.

**Acknowledgements**

I would like to thank Mrs. Silva and Mrs. Zalataforo for motivating me to finish this project and also for keeping me focused and on a schedule even though it was rather hard at times. I would also like to express my gratitude to Ms. Shelby Bartram for answering my questions and for praising me and motivating me through it all.
Title  All-in-One Basketball Training System

Summary
There are a lot of devices and equipment to help basketball players increase their skills.

There are three main skills needed to play basketball: dribbling, passing, and shooting.

The purpose for creating this project is to help basketball players be able to practice all of the skills at once by creating a training system that combines the three required skills all into one apparatus.

This project is a brand new design that has never been created before. This product will help make basketball players better because they will have to practice shooting like there is a defender on them. Also, a basketball player can practice dribbling into a jump shot. The main purpose of this product is to combine different pieces of equipment together into one functioning training system.
Abstract

Basketball is one of the most well known sports around the world. According to the National Sporting Goods Association, over 35 million people play basketball in the U.S. About 450 million people play basketball worldwide according to FIBA. So many people play basketball, but there is not a product where an athlete can practice shooting, dribbling at home and alone by themselves. There are some products like the D-Man, Universal Shot Trainer and Drimbble Stick. The D-Man is a stationary defender that a basketball player can practice shooting over. The Dribble Stick is a stationary stick that has positions that stick out that an athlete can practice dribbling under. The Universal Shot Trainer is a combination of both the Drimbble Stick and D-Man. This device allows a player to practice dribbling and then practice shooting over a defender.

Methods

1. Sketch a 2D version of the project.
   - Graph paper will be used to create a sketch. Each color represents a foot. The height of the shoe is 3.5 inches, which means that the real project will be 3 ft. The width of the sketch is 4 inches, which means the real project will have a width of 4 feet.

2. Sketch a 3D version of the project.
   - For the 3D sketch, the same 2D sketch was used, but extra lines were added to make it look 3D.

3. Build the project on Autodesk Inventor.
   - Autodesk Inventor is a computer program that allows people to create a 2D sketch and then export it. Autodesk Inventor is the software used to create the project in real life. All of the measurements would be multiplied by 12 (to create the project in feet). The dimensions on Inventor are in inches tall and 4 inches wide. Since the project will be made out of PVC, the diameter of the project on Inventor is 2.5 inches.

4. Decide what materials the training system would be made out of.
   - Black pipe or PVC pipe would be the best options for this project. These were once and cost to both types of pipe. The PVC was cheaper than the black pipe, but it was not as strong and will not be able to withstand as much impact. The best option for this project was go with black pipe.

5. Buy the materials.
   - 2” x 4” caps
   - 6’’ x 12” elbows
   - 1” x 1” pipes with an extra hole
   - 1” x 2” PVC pipe
   - 2” x 4” x 1” Black Steel Pipe Nipple
   - 6” x 2” Black Pipe
   - 1” x 4” x 4” Black pipe
   - 2” x 3” x 3” Black pipe

6. Build the frame out of black pipe.
   - One 5 ft piece of pipe and one 4 ft piece of pipe were connected together to make a 9 ft piece. Then, that piece was repeated. One elbow was placed on each 6 ft piece. Then, screwed a 4 ft piece into the two elbows, so it looked like a rectangle, but with flat bottom piece.

7. Attach Supports.
   - A square was made by using the 2 ft pieces, then it was attached to the basic to add extra support.

8. Attach a piece of PVC to the frame so it sticks out and it will act like the Drimbble Stick.
   - There was one hole that had an extra hole because that was where the PVC was going to be used to block the dribble spot.

9. Attach the soccer net to the inside of the frame.
   - A soccer net was going to be added to the inside of the frame, so athletes could practice passing. An athlete would throw the ball at the net and the ball would bounce back at them, then they could shoot the ball. This aspect simulates a player receiving a pass in a game, then shooting the ball.

Results

For this project to be considered successful, all aspects of the final product would have to function properly. A basketball player would have to use this project and feel like it would improve the way they would play.

Discussion

The next step for this project would be to complete the frame and the rest inside of the frame. Also, if there was more testing would have taken place. The only way to test this project is to see if it is actually functional.

There were a couple of things that made this project go smoothly. Creating the project on Autodesk Inventor made it easier to visualize. Also, making little sketches throughout the entire process really helped. While making those sketches, things could be tweaked and improved.

If this project was to be re-done, less time would be spent using Autodesk Inventor because even though it was very helpful, it just looks like too much time was spent using it. Autodesk Inventor would be used in the future, but less time would be spent trying to figure it out and creating the project on the computer. Also, there would be time to finish the project and add the netting to the inside of the frame. Adding the netting was going to take a good amount. After it was attached to the inside of the frame, it would have to be tested to make sure that if a basketball player throws a ball at it, the ball will return, when the ball is thrown at it, the entire project will not fall over because of how much impact is applied to it, and to make sure that the netting would stay in place once a ball is thrown at it. If there was more time to test the project, a lot of things could have been changed. In the future, gullity of time would be left aside to test and make any final adjustments.

Acknowledgements

I would like to thank the STEM Academy for letting me do this project because I was so interested in doing it. Also, my mentor Mr. Sanfor for helping all around with the project because I needed some help and guidance and Mrs. Skica for helping me with all of the little things.

References

Title  
Mouth Guard Force Testing

Summary
Mouth guards are protective equipment used in sports to prevent dental injuries and absorb force applied to the lower jaw. They are important because dental injuries may not only sideline players but may be expensive to repair or even cause permanent disfiguration of the teeth and jaw.

The purpose of this experiment is to identify which mouth guards are the most effective and why. Athletes should know which mouth guard is the most effective at preventing injury.
Mouthguard Force Testing
Edward K. Dalrymple
Senior, Elkton High School STEM Academy

Abstract

Mouthguards are protective equipment used in sports in order to prevent dental injuries and absorb force applied to the lower jaw. They are important because dental injuries may not only sideline players but may be expensive to repair or even cause permanent disfigurement of the teeth and jaws. The purpose of this experiment is to identify which mouthguards are the most effective and why mouthguards are the most effective. The effectiveness is determined by the net force measured by the GDX-FOK sensor. The lower the force produced, the more effective each mouthguard will be. This is relevant because athletes should know which mouthguard is the most effective at preventing injury. Originally, the effectiveness of each mouthguard was supposed to be determined by an instron machine. Unfortunately, there were no available instron machines that were able to be used.

Background

A mouthguard is a piece of protective equipment typically used in order to prevent dental injuries and disfigurements for athletes. Mouthguards are somewhat controversial, as some studies say that they also help reduce concussions in athletes, but this is yet to be proven. There are a wide variety of variations in different brands, shapes, and sizes of mouthguards. Figuring out which types of mouthguards are more effective in absorbing the force of a projectile is important because this would help athletes more awareness and clarity when it is time to select a mouthguard. The three mouthguards tested in this experiment were the SISU go, Shock doctor gel max, and Venom challenger. The SISU go may perform better in the experiments due to its being composed of a harder material than the other two mouthguards.

Research

Whether or not mouthpieces prevent concussions has been debated in the medical community for quite some time. The article “Effect of Mouthguards on Dental Injuries and Conclusions in College Basketball” by Labella, C. R., Smith, B. W., & Sigurdsson is a source that explores common injuries in college basketball and the frequency of which they occur. The article has data stating that 0.35 athletes per 1000 athletic exposures experience concussions wearing mouthpieces vs. 0.55 athletes per 1000 athletic exposures not wearing a mouthpiece do experience concussions. It also shows that mouthguards significantly reduce dental injuries and referents (0.12 v 0.67, P < 0.05, 0.00 vs 0.72, P = 0.05).

Methods

1. Hook up the GDX-FOK sensor to the chrombook via bluetooth connection and start up graphical analysis four.
2. Place testing apparatus under tube where the cross in the base intersects
3. Place one of the three mouthguards into the apparatus
4. Drop the projectile down the tube
5. Measure the maximum force applied to the sensor on the graph
6. Complete multiple trials for the mouthguard, measuring the max force on the force/time graph.
7. Repeat using all three different mouthguards

Results

Testing apparatus without replica jaw
Testing apparatus with replica jaw connected to a chrombook
Tube that the projectile is dropped down through
Materials of the testing apparatus before assembled

Testing Materials

SISU go
Shock Doctor
Venom Challenger

Discussion

The purpose of this experiment was to assess which mouthguard between three popular brands displays an ascending impact force from the lower jaw. The outcome of the experiment had not been concluded due to unfortunate circumstances, but it is reasonable to believe that the SISU go mouthguard would produce the least amount of measured by the GDX-FOK sensor because the SISU is composed of a harder material than the other two mouthguards and it is also a smaller mouthguard making it more comfortable to wear and easier to breathe through. The shock doctor gel max and the venom challenger are composed of similar gel-like materials composed of a harder exterior shell and soft lining that helps the mouthguard fit. The SISU go is also the most cost effective option as the other two were more expensive. Not having access to an instron machine may have hindered some progress in this experiment. A large portion of time that was allotted was used communicating with different corporations and institutions that had access to the machine, but unfortunately due to safety concerns and clearance issues the machine was unable to be utilized for this project. It is important that all athletes stay safe in their endeavors and figuring out which mouthguard will protect you the best is an important step in doing so. All three mouthguards tested are good cost effective options in order for athletes to protect themselves, but the SISU go is ultimately going to be the best mouthguard in terms of protection, cost, and comfortability.

References/Acknowledgements

I would like to thank Shelby notorious, Biomedical Engineer at UCSC, Chemical Biology Center for her guidance and assistance.
Introduction
Criminal profiling is the analysis of a person's psychological and behavioral characteristics. These characteristics are used to assess whether or not a person has committed a crime that is under investigation. Over time a ViCAP form was created and has changed from only using it to track cars and guns to comparing different cases for overlap and similarities to narrow down the suspect field.

Profilers work in the BAU unit of the FBI. They play an important role during a investigation. They work with a unit called ViCAP (Violent Crime Apprehension Program). This program helps to facilitate communication between law enforcement agencies and to apprehend serial offenders.
Criminal Profiling

Ciera Davison, Elkton High School Grade 12
Homeland Security and Criminal Justice, Cecil County School of Technology

Introduction
Criminal profiling is the analysis of a person’s psychological and behavioral characteristics. These characteristics are used to assess whether or not a person has committed a crime that is under investigation. This was invented in 1890 around the time of Jack the Ripper. Over time, a VCAP form was created and has changed from only using it to track cases and guns to comparing different cases for overlap and similarities to narrow down the suspect field.

Profilers work in the BAU unit of the FBI. They play an important role during a investigation. They work with a unit called VCAP (Violent Crime Apprehension Program). This program helps to facilitate communication between law enforcement agencies and law enforcement specialists.

Figure 1. Profilers help to figure out “who, what, and why.” They help narrow down a suspect field by having a detailed investigation of a crime scene

Methods and Manor
Profiling happens in a step by step process. The process is as followed: (1) profiling inputs, (2) decision-process models, (3) crime assessment, (4) the criminal profile, (5) investigation, and (6) apprehensions.

Profilers come up with someone called the victimology. This is just the study of the victim’s life. How did the victim(s) spend their everyday life? This help them find overlaps between each victim and possible find out if they met the usual (offender/unknown subject). Profiling can be compared to “reverse criminal psychology.”

Clemente, a retired FBI agent. Clemente explained there are less important aspects being investigated in detail by the BAU that regular law enforcement wouldn’t think would be important. Criminal profilers have a different set of eyes when it comes to explaining pieces of information.

Figure 2. This illustrates the different lens that profilers look through in order to find out information and give meaning to things such as location and position of the body. Things you and I might overlook or find no importance in.

Popularity
You may have heard the term “criminal profiling” before for a couple reasons. (1) you are way too interested in crime television, and (2) you have watched a ton of crime television. Maybe you have watched the TV show Criminal Minds or the 1991 film Silence of the Lambs. Both of these give insight into what profilers and analysts do and how a crime gets solved. Please keep in mind it is only TV.

What has your crime television really taught you? Would you know how to get away with murder? Probably not. Would you know how to solve a criminal investigation? Again, probably not. How much information would you be able to pull out of things such as:

- Location
- Victimology
- The organization/ sophistication level of the offender
- Pre and Post-behavior

Figure 3. These are the most popular of their craft. The most popular crime TV show and the most popular crime movie. Both are very insightful to those with naked eyes. In reality, these shows or movies only gives us a taste of what the FBI and the BAU and all the other units actually do.

The things they don’t tell you
These shows and movies don’t tell you everything. The time it takes for the FBI to even be brought on a case. All of the paperwork that goes into the investigation. One form is called VCAP. This is a 40 page form that sometimes could require printing multiples of the same page. Things don’t work so speedy the way they do on the television.

This form isn’t only for serial killers. It is used for homicide, attempted homicide, missing persons, child abductions, sexual assaults, and unidentifiable deceased persons. This form helps create and identify patterns between multiple cases which then is need to create a profile and eventually, hopefully solve a case.

Figure 4. This is the logo on the 40 page form. It is split into 16-17 sections. VCAP maintains a nationwide data information center that collects, collates, and analyzes crimes of violence

Organized vs Disorganized
You may have heard of the Macdonald trial. This is kinda like “you should have known your sometime was gonna grow up to be a murderer.” If a child does all three of these thing, please be worried.

Killers are placed into one of two categories: organized vs Disorganized. Organized. See table below.

Figure 5. This is the McDonald trial. Bed weaving, animal cruelty, and a fascination with fire and fine-setting. Please watch your kids.

Conclusions
In conclusion, criminal profiling is important. The world we live in is cruel and can be unforgiving. Profilers work very hard to be successful at their jobs. Not everything is 100% but neither is running, sales associates, teachers, food service workers, law enforcement, etc. Sometimes people fall or get something wrong. This is why there are cold cases. Sometimes a profile could be slightly off leading law enforcement to be looking in all the wrong places. However, as time goes on, the BAU has gotten stronger and developed more skills to be the most accurate as possible.

The golden rule: treat others how you want to be treated. Remember to always be respectful to any government officials if you ever end up in the unfortunate situation of going through this for a loved one. There are support groups for the victims family and friends available. Don’t be shy to join because seeking help is better than ignoring the situation.

Figure 6. This represents someone who has been arrested and the things they may have faced growing up or who they have become. Some examples are stuck up white boys, ruthless and severely damaged men or women of any race

Acknowledgments
I would like to thank Mr. Walter Bateson, the homestead teacher in the entire world. I would also like to thank my friends for supporting me and pushing me to my breaking point. I greatly appreciate all of the websites and documentries I watched and read for helping this process.

For further information
Do your own research and don’t believe everything you see on the television.

ELKTON HIGH SCHOOL
Ivan Galindez
Grade 12
Elkton High School

Title  Teacher Academy of Maryland
Can’t Stop, Won’t Stop

Summary
Student will be able to complete a rigorous, college-level program that is based on the outcomes of the Maryland Associate of Arts in Teaching (A.A.T) degree, which aligns with the National Council for the Accreditation for Teacher Education (NCATE) standards by exploring Human Growth and Development, Teaching as a Profession, Foundations of Curriculum and Instruction and participating in an Education Academy Internship in a CCPS school.
Teacher Academy of Maryland
Ivan Efrain Galindez

Topic: Can’t Stop, Won’t Stop

Outcome / Objective:
SWBAT (Student will be able to) complete a rigorous college-level program that is based on the outcomes of the Maryland Association of Arts in Teaching (A.A.T) degree, which aligns with the National Council for the Accreditation for Teacher Education (NCATE) standards by exploring Human Growth and Development, Teaching as a Profession, Foundations of Curriculum and Instruction and participating in an Education Academy Internship in a CPSS school.

Activities:
1. First Lesson - My first lesson that I presented to TAM was How to Make Empornadas. This was lesson was very successful because it was our our first time to teach in front of the class. I tried so hard to keep myself calm, cool, and collected. We also had to create slides for our presentation and bring in supplies. First I showed my classmates where to get the Empornadas discs, then how much meat they needed for each Empornada and how long to fry them. It was more like a visual representation with everything already prepared and step by step slides on how to do them. This really taught me alot on how the teaching world really works and the struggles our teachers go through to make lesson plans, assignments, activities and that it is not an easy task.

2. Toy Creation & Sales Pitch - This lesson was made by my classmate Ian Racine and I. We had to create our own toy, this was one of my favorite lessons throughout my TAM experience. First we had to create an advertisement for our classmates, because in the real world that is how you sell your stuff by good advertisements. So we included in our slide an awesome photo with Ian holding the “Powerful Giibi” and the price and how great the toy was to make our toy intriguing to the others.

3. Cooperative Learning Activity - This lesson was to see how well I could keep my students engaged in the lesson. My idea was to make a Tamby tree with all the things that we are grateful for. I split up the class into four groups, I purposely did this to have all my students work together. In those four different groups they all had to make either the tree, background of poster, hand turkey, or bubble letter title. The groups were all given supplies selected for that group. Then near the end I had everyone cut out leaves I made for them to put on the tree on what they were thankful for and I customized slides for each of my classmate with their name to come and say what they were thankful for and at the end we would come together and make the finished product as a family.

4. Bulletin Board - What I did for my bulletin board activity was “Spread your wings and fly high”. This was very memorable during my TAM experience and being with my fellow classmates and hearing what their biggest dream is. What I did was I got blue poster paper to make my activity and art stand out. Then I used a cutting press machine to cut out butterflies and letters to spell out my title. Then I realized that there was something missing. I went home and made a kid with their hands out letting the butterflies go and they had a big red heart in the middle to show love and dedication.

5. Internship - My internship was a phenomenal experience, I enjoyed every second of it. My Mentor was Mr. Nai, my Wicdigis Special Educator. We went from classroom to classroom helping students, reading books together, doing computer work, and tests. This experience really did show me the struggles and passion that teachers go through and I thought it was amazing getting to know each and every of one of my students, them asking me for help, telling me they didn’t want me to leave, and to read with them. I have no regrets on selecting Teacher Academy at Cecil County School of Technology and I can’t stop what I love and the passion I have for helping kids move forward and going beyond and I will not stop. That is what I learned from TAM.

Closure:
Upon completion of the TAM program, I want to apply to be a paraprofessional in a school in Cecil County, to help my students in need and gather more knowledge and experience to be a teacher. Then I will go to Cecil College for two years to be a Special Educator. After that I will apply to University of Delaware to finish my Bachelor’s degree and be a Special Education Teacher in Elkton High. After Mr. B retires I will apply for his spot at School of Tech.

Assessment:
I believe that I learned to be dedicated and patient in TAM. I learned I am patient, caring, and kind and that when working in the field of teaching I am very serious, not in a mean way, but a strict and loving way. By getting my student’s back on task or when they are not doing what they are suppose to do I put them back on track in a serious and modest way. Also I learned to be a teacher you have to be dedicated to work for your kids and yourself because if you don’t you will not make it and all the great teachers that I have met have dedicated time and love to everything they do and that makes up an outstanding teacher with the ability to connect with their students and have patience. That is what I learned in TAM. My overall TAM experience was amazing I loved meeting everyone from different schools, seeing my teachers there every other day, and getting to learn new thing on how to be a fantastic teacher and what I learned from working with others is you have to be patient with them and yourself to successfully achieve what needs to be done.

Homework:
Attend Cecil College as major in Special Education
Apply for a job as Paraprofessional then as a Special Educator
Future Goals: To be a Special Educator and Support my family

Acknowledgments:
Kelly Ehringer – TAM Instructor
Matthew Berkheimer – Special Educator CSST
Deanna Jaeger – Special Educator EHS
Angela Eicher – Special Educator EHS
Melanie McDonald – Special Educator EHS
Title  
**Growth Bacteria in Reusable Water Bottles**

Summary

Reusable water bottles are used daily by many people. There are many different reusable water bottles ranging from hard plastic to copper, however many people do not know that each of these water bottles can have a negative health effect if not washed after each consumption. The goal of this investigation is to evaluate which water bottle (hard plastic, copper, stainless steel or glass), retains the most bacteria in a two week period.

This experiment showed that the stainless steel bottles retain the most bacteria over a two week period and that the hard plastic bottles retain the least amount. This development is from the different types of water bottles but could also have had these results from the different shape and size of each bottle.
Growth Bacteria in Reusable Water Bottles
Ciara Hopkins
Junior, Elkton High School STEM Academy

Abstract
Reusable water bottles are used daily by many people including employees, athletes, students and many group of people. There are many different reusable water bottles ranging from hard plastic to copper, however many people do not know that each of these water bottles can have a negative health affect if not washed after each consumption. The goal of this investigation is to evaluate which water bottle (hard plastic, copper, stainless steel or glass) retains the most bacteria in a two week period. This was done by growing bacteria in four different types of reusable water bottles (recessed above) by leaving water in each over a two week period and allowing for bacteria at one week to track the growth and two weeks to receive the results. Bacteria was then grown in the incubator and a coliform plate count occurred after then compare the result from each reusable water bottle. This experiment showed that the stainless steel bottles retain the most bacteria over a two week period and that the hard plastic bottles retain the least amount. This development is from the different types of water bottles but could also have had these results from the different shape and size of each bottle.

Methods

Procedure to test:
1. Clean and wipe down the testing area, put on gloves and make sure all hair is pulled back and goggles.
2. Take 100 ml of Carolina bacter agar out and begin to melt each in the microwave for 30 seconds at a time or boil water in a beaker on the hot plate (move in a circular motion to break up the clumps and have the lid half open to release air).
3. During the waiting process take out four 100 x 15 mm petri dishes and write the name and type of water bottle the bacteria is coming from. This should be done on the back of the petri dish.
4. The bottles should be filled with 260 ml of tap water and check the room temperature should be at 71 degrees Fahrenheit and the water should be at 23 degree celcius.
5. Let agar cool for 10 minutes.
6. When the agar has cooled to the touch begin to pour, lifting the lid at a 45 degree angle to keep away any possible bacteria that could get in (make sure the bottom of the plate is completely covered).
7. Wait about 15 minutes to let the agar harden before washing and applying.

Discussion
Throughout this project different water bottles were tested for bacteria growth over a two week time period. The bottles that were swabbed were bottles that were used on a day to day basis by many people. The results did not match the hypothesis. The copper bottle was thought to be the most sterile bottle after much research, however the data says otherwise. The bottle that was the second most bottle retaining the most bacteria. The hard plastic bottle was thought to be the least sterile bottle however throughout all these trials the bottles retained bacteria after analyzing the bacteria colony plate count. The copper bottle made did not match some of those reasons for the data includes the fact that the "wash" in between each trial did not give the bottle an exact foundation to know that they were both clean. This could have been avoided by washing with soap and water very thoroughly keeping the amount of soap, type of soap, cleaning supply and amount of water the same. Also after doing the basic culture test and scoring the results that there was previous bacteria in the water bottles, that should not have been the case being that they were brand new. Another trial within the experiment could have been the temperature of the room that the bottles were being kept in; when the water was initially poured in the temperature was taken account of that is not to say that it could have floated through the night and into the day affecting the results because the material of each bottle could have reacted in a different way.

Results
In this investigation three trials were conducted after a baseline test. The baseline test was supposed to show that each bottle was clean with no bacteria left being used to compare results after testing. However after the baseline test looking at the coliform plate count copper had one bacteria count as well as stainless steel, hard plastic and glass had no bacteria in expected. Each trial was a two week period and during that time each bottle was swabbed after one week to track the growth of bacteria. In the first trial after two weeks stainless steel had accumulated a bacteria count of 96, copper and glass ending with 0 and hard plastic being swabbed finding no bacteria during the coliform plate count. Before the second trial the bottles were washed out with distilled water to replicate giving them a clean base to start out with for more accurate results. After the second trial stainless steel still had the most bacteria growth with a count of 85 and then copper with 23 and both glass and hard plastic finding no bacteria. In my final trial the glass bottle had a bacteria count of 24 and stainless steel, copper and hard plastic had none. The test statistical analysis was used to prove the null hypothesis wrong, that bacteria growth was not affected in water bottles made from different materials. However after conducting the test and receiving a t-value above 0.55, being 213, this experiment was not able to reject the null hypothesis.
Title  Tools for Fighting Wildfires

Summary
To improve the efficiency of wildland fire teams, this project is based on combining the capabilities of the Pulaski, Combi and Fire shovel tools to create an all purpose tool every team member can carry. In doing so, a wildland firefighter team will be able to complete tasks within less time and more effectively than before. This will increase the abilities of a fire team as well as reduce their exposure to the dangers of a wildfire.
Tool for Fighting Wildfires

Ethan Kirk
PLTW Engineering Design and Development, Elkton High School

Abstract
To improve the efficiency of wildland fire teams, this project is based on combining the capabilities of the Pulaski, Combi and Fire shovel tools to create an all-purpose tool every team member can carry. In doing so, a wildland firefighter team will be able to complete tasks within less time and more effectively than before. This will increase the abilities of a fire team as well as reduce their exposure to the dangers of a wildfire.

Introduction
Over recent years, our environment has faced an increasing number of more intense forest fires than ever before. In order to stop the destruction of these natural disasters, teams of trained wildland firefighters from all over our nation are dispatched for 21 days at a time to fight these fires. These teams carry out a number of missions from dropping trees to digging trenches and chopping up roots. All of these things are in an effort to stop the spread of the fire. There are 3 manual tools that are used for such tasks: The Pulaski Tool, The Combi tool and the Fire shovel (Figure 1). The issue this project is addressing is that each of the tools listed above serves a different purpose, and a team member may only carry one. This means that during any given task a team may be undertaking, only members with the appropriate tools can complete the job while others aren’t being utilized with appropriate efficiency while constantly in the face of danger. This project aims to improve the efficiency of a wildland fire team, reducing their overall exposure time to the fires, and reducing their hazard rate as a result.

Constraints
The design must be able to combine all the capabilities of the three separate tools. Digging, chopping roots and raking are what the design must be able to do. Weight is also a factor that must be taken into account.

Conclusions
As the project progressed, the emphasis became on combining the capabilities of the Pulaski Tool and the Combi tool, as the Combi tool already has a shovel feature. While several designs were created and investigated, time ran out before one could be chosen and tested.

Literature cited
Climate Change and Wildfires
Fighting Wildfires
https://www.coj.gov/wildfire/topics/protecting/protecting.html

Acknowledgments
I thank Mr. Cline for his ready assistance with the project, its research, and guidance in finishing the Gallery Walk Presentation. I also want to thank my Parents for their support and my Dad for providing the project materials.
Title  Vallisneria Americana in the Phytoremediation of Phosphate

Summary
From the climate crisis to overpopulation, understanding how human activities affect the natural processes of other living things on this planet is necessary now more than ever.

Submerged Aquatic Vegetation (SAV) provide organisms in their environment with many benefits such as food, shelter, and clean water by absorbing excess nutrients, like phosphate, in the water. Without underwater grasses, these nutrients would be utilized by algae that would grow to create many adverse effects for the other organisms.

The purpose of the study is to determine the rate at which phosphate is remediated from different water sources in the presence of wild celery (Vallisneria americana), an underwater grass.
Vallisneria Americana in the Phytoremediation of Phosphate

By: Ryan Knight

Background
From the climate crisis to overpopulation, understanding how human activities affect the natural processes of other living things on this planet is necessary more than ever. Submerged Aquatic Vegetation (SAV) provides organisms in their environment with many benefits such as food, shelter, and clean water by absorbing excess nutrients, like phosphorus, in the water. Without underwater grasses, these nutrients would be utilized by algae that would grow to create many adverse effects on the other organisms including blocking sunlight and decomposing through processes that consume oxygen. While the grasses work to combat this by using up the nutrients first, they are sensitive to waters with high levels of nutrients such as those polluted by industrial runoff.

The purpose of the study is to determine the rate at which phosphate is remitted from different water sources in the presence of wild celery (Vallisneria americana), an underwater grass. Phosphate is an important nutrient for plants. For example, it is used to make ATP, a molecule used in photosynthesis. Wild celery is an underwater grass that occurs naturally in the Chesapeake Bay and is used in aquariums for its water purifying abilities. The information garnered from this investigation will allow for a better understanding of how severe water pollution is and how effective phytoremediation is, the process in which plants are grown to detoxify their environment (Runnau, 2015), may be as a solution to the pollution crisis. The null hypothesis is that the rate of phosphate remediaiton will not differ between the groups with and without wild celery.

Materials:
- 4, 2 gallon plastic buckets
- 4 airpumps
- 4 tubes
- 12 “10watt” 12v soft white light bulbs
- 2 clear plastic tube with lid
- 2 rings stands of equal heat
- 3.5 gallon bucket feed with substrate
- 12 liters of water from each source
- 2 bunches of Vallisneria americana (wild celery)
- LMolite Phosphate Test Kit
- Plastic pipettes (4 for each day of testing)
- Aquarium burners
- masking tape
- permanent marker
- distilled water
- clinometer
- paper towel
- scale

Methods
The average rate of remediaiton was 0.167 ppm per day for both the Meadow Park and Charleston Beach groups with wild celery present and 0.05 ppm per day for both control groups. The mean of the Meadow Park control group was 1.9ppm, while the mean of the Charleston Beach control group was 1.8ppm. The mean of the Meadow Park group with wild celery was 2.1ppm, while the mean of the Charleston Beach group with wild celery was 2.2ppm. Wild celery showed no statistically significant effect on the concentration of phosphate in the environment. Over the 26 days, the mass of the wild celery in the Meadow Park group decreased by 47.8%, while the mass of the grasses in the Charleston Beach group decreased by 41.3%.

The amount of light, water, and substrate each group received were all kept constant. Results were analyzed using the One-Way ANOVA test because the experiment studied the effect of one independent variable (presence of wild celery) on the phosphate concentration of the water across different water sources, and the test compared the means of each group.

Conclusions
The results of the experiment yielded a p-value of 0.916, meaning wild celery had no statistically significant effect on the concentration of phosphate in both water sources. This alleviates our null hypothesis to be rejected. This study does not prove wild celery to be effective in the phytoremediation of phosphate. The removal of phosphate that did occur was likely due to the initial death of some of the plants that likely increased phosphate concentration and the small amount of growth afterwards that may have led to the large presence of algae across all groups. While the algae may have increased the phosphate concentration, creating the desired effect in the study, increased algae growth could still be detrimental to aquatic ecosystems. This study did not have measures to combat algae growth or plant death, and this may have contributed to the lack of statistically significant results. Because research concluded that aquatic plants were effective at absorbing excess nutrients and preventing future growth upon repetition of this study or similar studies is necessary to further investigate these claims.

As the climate and pollution crises continue and the harmful effects of human activities become more apparent, it is imperative that humans are able to find ways to preserve the environment in order to continue to survive. Over 70% of the Earth's water, so the survival of aquatic ecosystems is integral to life on the planet. Without a way to prevent or remediate pollution in these ecosystems, life on Earth is at risk. Phytoremediation may be promising because it integrates natural elements of that ecosystem and removes the pollution, so the continued investigation of this process may yield a solution and a promising future for the planet.

References

Acknowledgments
I would like to thank Kris Goss, my mentor, for her advice and support throughout this study. I would also like to thank Jennifer Amma, the environmental science teacher at Elkton High School for having me as her test kid. Finally, I would like to thank my STEM teacher, Leah Soha, and the CCSPS STEM Advisor, Christine Zelata, for their encouragement throughout this past year as well as for inspiring and challenging me throughout this project.
Title  Ankle Sprains on Different Surfaces

Summary
The goal of this research and experiment was to decipher on which playing surface an athlete would more likely experience an ankle sprain. An analysis and comparison was done by testing the amount of pressure resistance a shoe and skeletal leg would have at different angles and on different surfaces. The study was conducted by designing and building a testing apparatus that was able to apply a constant force from specific angles. The different surfaces that the apparatus and skeletal leg were tested upon were concrete, natural grass, short turf, and long turf.

After testing, there was no direct conclusion of which surface was most likely to cause an ankle sprain; however, the data did reveal that the shoe experienced the most slipping on the long turf which signifies that the chance injury is uncertain as the athlete would lose control while cutting.
Ankle Sprains on Different Surfaces

Cameron Michalak
Elaton High STEM Academy

Materials
- Wood (13.55 x 3.5 cm, 2 x 3 x 0.76 cm)
- Drill
- Drill bit
- Screws
- Testing surfaces
- Metal rod
- Air compressor
- Air hose
- Pneumatic cylinder
- Skelton leg
- Athletic shoe size (7)
- Cleat
- Two resistance pressure sensors
- Flats
- Two wire leads
- Two multimeters
- Tachometers
- Rp ties
- Tape
- Weights

Procedure
1. Build a wooden base that is 35.5 cm x 30.5 cm.
2. Create two pillars each 76 cm tall on either side of the base.
3. Add a 35.5 cm wooden plank across the top of the two pillars with screws holding them in place.
4. Drill holes in each of the two pillars, at 10 cm, 12 cm, 15.2 cm, and 17.8 cm to test the effect of different angles.
5. Make angle supports to the pillars and put 100 lbs. to stabilize the back. (Fig 2)
6. Collect an air compressor and an attached air hose. Also, make a pneumatic cylinder that can be connected to the air hose. (Fig 3)
7. Collect multimeters that are capable of reading resistance in kilos ohms (kΩ) along with the wire leads and resistance pressure sensors. (multimeter-60 thin film sensor—Amazon.com) can be attached.
8. Collect a tachometer leg, 7-inch athletic shoe and cloth. Place resistance pressure sensors on the bottom of the heel for vertical pressure and one resistance pressure sensor on the side of the foot for lateral. Put foam on top of the sensors then tape the foam, sensors and skeletal foot together.
9. Wrap the skeletal foot in cloth then place it in the shoe. Tie the shoe firmly tightly. (Fig 4)
10. Attach the chips of the wire leads to the sensors and plug the other end into the multimeter.
11. Use brackets, zip ties and tape to connect the top of the skeletal leg to the pneumatic cylinder.
12. Use the rod and put it through the hole on one pillar then through the pneumatic cylinder and then through the other pillar.
13. Now that the testing system is set up, make sure everything is fully functional.
14. In separate trials, turn the PSI leads on the air compressor so the increments 0, 20, 30, 40, 50, 60, 70 and 80. At each increment, wait until the multimeters have a steady reading and record it in a table.
15. After both the vertical and lateral component pressures are recorded at each PSI increment, adjust the rod and pneumatic cylinder to the next angle by rotating it from the center hole and moving it on to the next one. Do the same at every PSI increment of every angle (72°, 65°, 55°, 45°)
16. Once all the angles of every PSI increment are collected, switch the surface by moving the apparatus and skeletal leg at once to the next surface.
17. Repeat steps 1-16 until all surfaces are completed. If extra time is allotted, go and repeat tests for more trials. (Figs 5, 7, 6, 8)
18. The data once collected can be moved to an online spreadsheet for analysis.

Discussion
Although the results of the experiment were inconclusive in terms of answering what the most harmful surface, the data gathered does show trends and useful information. The original null hypothesis cannot be refuted in the statistical analysis showed that there was no difference in the surfaces when looking at the rates of vertical to lateral force and surface type. (Fig 9)

Acknowledgments
I would like to thank my mentor, Dr. Kaminski, for his insight, advice, and expertise to help me think outside the box through the planning stages of my project. I would also like to thank my Dad who sided into the data collection and analysis by exposing me to graphing through computer programming, and my mom who encouraged me to not give up through the process. Lastly, I want to thank Mr. V for being a fantastic year in the STEM class, for pushing my boundaries, and giving me countless amounts of advice through my project.
The Effects, Statistics, and Causes of Familicide

Solutions
Many government agencies have found that solving the case and locking the criminals up for life is the only solution to familicide. But what if we tried something to help prevent the crime?

If you have been abused or neglected by your parents visit a local therapist. If you or your parents have a history of violence or unknown mental illnesses visit a local screening center and see what the scans will say.

If you see a student acting out and threatening other students in school say something, tell the closest adult and call the Maryland Restorative practices. There are ways to help, you may save a life today.
The Effects, Statistics, and Causes of Femicide

Annalise Swain
Criminal Justice/Homeland Security, Cecil County School of Technology

Factors

Factors include a type of murder or murder-suicide in which a man kills one or more of his family members. The factors include:

- The killing of one’s parents
- The killing of one’s children
- The killing of one’s spouse(s)
- The killing of one’s spouse

Mythological and Biblical History

Mythologization: The Earth Goddess, Gaia, wanted to rid of her husband Ouranos, so she hired Cronus (son of Ouranos) to do so. Cronus then killed his own brothers and sisters after being born from his father’s death.

Case: Christopher Watts

Christopher Watts took his children and his wife’s dead body to isolated oil drums. He killed Chris, the youngest, first. He then covered her body in the barrel and went for Bella. Bella pleaded for her life, but unfortunately the four-year-old was unable to save herself. Shan’ann’s body was buried in barrels away from the oil barrels and wrapped in the bloody beds sheets Chris used to kill her.

There are a higher number of cases of men killing their wives over money and property. Fathers will only kill their children if he is unable to stop himself at the death of his wife. Men also kill their family over a mental illness that has gone untreated or ignored. (Fig. 4b)

There are two types of killings: a type of murder-suicide in which a man kills one or more family members. The killing of one’s spouse(s) is the most common form of killing.

Solutions

Many government agencies have found that the cause of the problem is lack of killings in the family’s solution to femicide. But what if we tried something to help prevent the crime? If you have been exposed to domestic violence please visit a local therapist. If you or your parents have a history of violence or unknown mental illness or a local crisis center and see what they can do. If you see a student acting out and threatening other students say something, tell the closest adult and call the Maryland Restorative Practices. There are ways to help, you may save a life today.

Being easily abased? Call 1-800-556-4473
Being abused as a child? Call 1-800-472-3453

Maryland Restorative Practices? Call 1-800-892-7400

Lit. cited


For further information

Please contact www.readgood.com/Seven Deadly Sins. For more information on this and related projects can be obtained at www.readgood.com.
Samuel Teigland

Grade 11
Elkton High School

Title  How Construction of Athletic Shirts Affects Absorption and Evaporation of Liquids

Summary
Various brands such as: Nike, Adidas, and Under Armor are all producers of some of the most popular athletic equipment and apparel in the world. Many of these brands sponsor and pay popular athletes to endorse and wear their product(s). The purpose of this experiment was to study how the construction and material used by these shirt brands affects the ability of each individual shirt to absorb and dry water over a period of time in a controlled environment.

The results and data were collected by subjecting all shirts to the same amounts of water, time, and conditions. After these time periods and being subjected to these conditions, the shirts were then removed from the testing environment and weighed a third time. All weights were recorded on a google spreadsheet throughout the entire experiment.
How Construction of Athletic Shirts Affects Absorption and Evaporation of Liquids

Samuel E. Teigland
Elkton High School STEM Academy

Abstract

Various brands such as Nike, Adidas, and Under Armour are all examples of companies that make athletic equipment and apparel in the world. Many of these brands have been interested in new ways to improve athletic products and use new technology to measure and track athletes. The data was collected by using various methods of measuring liquids that were applied to an athletic shirt. When water was applied to the shirt, it would be absorbed and evaporated over time. The data was analyzed using various statistical methods to determine if there were any significant differences between the brands of shirts.

Methods

1. Incubator Data
   a. Incubator data into 6 & 6 centimeter squares.
   b. Weigh shirts and record the weight.
   c. Place the shirts into a laboratory centrifuge for 45 minutes at 60 degree Celsius.
   d. Weigh shirts and record the weight.

2. Laboratory Centrifuge
   a. Cut athletic shirts into 6 & 6 centimeter squares.
   b. Apply 3 ml of water to the shirt.
   c. Record the weight after the 45 minute centrifuge.

3. Microscope
   a. Cut each shirt into a small square to be analyzed.
   b. Place it under the microscope.
   c. Zoom in and focus as needed.
   d. Take pictures (2-3 pictures).

4. Electron Microscope
   a. Cut each shirt into a small square to be analyzed.
   b. Glue to a material that does not conduct electricity, or else electrons will provide no meaningful picture.
   c. Place material inside the electron microscope.
   d. Focus and zoom as needed.
   e. Take videos and pictures (3-D pictures and videos).

The independent variable of the experiment was the construction of each athletic shirt, and the dependent variable was the performance of the athletic shirt, as defined by each shirt’s ability to absorb water, display it, and get it evaporated in a fast and efficient manner.

Results

On average, both of the cotton control variation shirts contained 3.0% of the 15 ml of water that had been applied to a 3 x 5 inch cotton surface. Because the amount of water per centimeter varied slightly, it was enough to completely soak all of the samples. The athletic shirts were all more efficient at absorbing, displaying, and evaporating water out of the three brands tested. The difference in the amount of water on the shirt was significant, with the Nike shirt containing 15.2% of the 3 ml of water still remaining on the shirt after the control. The Adidas shirt contained 15.4% of the 3 ml of water still remaining on the shirt after the control. The Under Armour shirt contained 41.8% of the 3 ml of water still remaining on the shirt after the control. The Nike shirt was able to evaporate and display 60.6% of its water weight (9 ml) in an hour. In Under Armour Heatgear, none of the shirts were able to evaporate and display 59.2% of its water weight (60 ml). In Under Armour Climalite, shirts were able to evaporate and display 57.2% of its water weight. This shows that there is a significant difference between the shirts, with Under Armour Climalite being able to absorb water and display it more than the other shirts. The P-Value for the test was 0.0057 (138 134), and therefore, reject the null hypothesis stating there is no difference between the contrast of the shirts and their performance because p is greater than 0.05. Figures 1 and 2 show both the incubator and the laboratory centrifuge test results. The laboratory centrifuge test was used as a second indicator and testing engine to show that the samples yield the same results when applied to different environments. The samples were attached using a sprayer gun to more closely match real-world conditions because water has a tendency to reduce the weight of the fabrics and thus the impact on the sample. The P-Value for the test was 0.0038 (10,259) and therefore, reject the null hypothesis stating there is no difference between the contrast of the shirts and their performance because p is greater than 0.05.

Acknowledgements

Many thanks to Dr. William Sheehy for his hard work and dedication to this project. This great project would have been impossible to achieve without his guidance and the opportunity to work under his mentorship. His help in allowing us to stay on track and in providing the necessary equipment and materials has been invaluable. Many thanks also to Mrs. Kiser and Mr. Zadrozny for making this project possible and their guidance throughout the entire project.

References

Throughout the experiment, different athletic shirts were exposed to different amounts of water to determine how the shirts perform under different conditions. The shirts were exposed to different amounts of water to determine how they absorb and display water.

Discussion

On average, both of the cotton control variation shirts contained 3.0% of the 15 ml of water that had been applied to a 3 x 5 inch cotton surface. Because the amount of water per centimeter varied slightly, it was enough to completely soak all of the samples. The athletic shirts were all more efficient at absorbing, displaying, and evaporating water out of the three brands tested. The difference in the amount of water on the shirt was significant, with the Nike shirt containing 15.2% of the 3 ml of water still remaining on the shirt after the control. The Adidas shirt contained 15.4% of the 3 ml of water still remaining on the shirt after the control. The Under Armour shirt contained 41.8% of the 3 ml of water still remaining on the shirt after the control. The Nike shirt was able to evaporate and display 60.6% of its water weight (9 ml) in an hour. In Under Armour Heatgear, none of the shirts were able to evaporate and display 59.2% of its water weight (60 ml). In Under Armour Climalite, shirts were able to evaporate and display 57.2% of its water weight. This shows that there is a significant difference between the shirts, with Under Armour Climalite being able to absorb water and display it more than the other shirts. The P-Value for the test was 0.0057 (138 134), and therefore, reject the null hypothesis stating there is no difference between the contrast of the shirts and their performance because p is greater than 0.05. Figures 1 and 2 show both the incubator and the laboratory centrifuge test results. The laboratory centrifuge test was used as a second indicator and testing engine to show that the samples yield the same results when applied to different environments. The samples were attached using a sprayer gun to more closely match real-world conditions because water has a tendency to reduce the weight of the fabrics and thus the impact on the sample. The P-Value for the test was 0.0038 (10,259) and therefore, reject the null hypothesis stating there is no difference between the contrast of the shirts and their performance because p is greater than 0.05.

The independent variable of the experiment was the construction of each athletic shirt, and the dependent variable was the performance of the athletic shirt, as defined by each shirt’s ability to absorb water, display it, and get it evaporated in a fast and efficient manner.

The samples were attached using a sprayer gun to more closely match real-world conditions because water has a tendency to reduce the weight of the fabrics and thus the impact on the sample. The P-Value for the test was 0.0038 (10,259) and therefore, reject the null hypothesis stating there is no difference between the contrast of the shirts and their performance because p is greater than 0.05. Figures 1 and 2 show both the incubator and the laboratory centrifuge test results. The laboratory centrifuge test was used as a second indicator and testing engine to show that the samples yield the same results when applied to different environments. The samples were attached using a sprayer gun to more closely match real-world conditions because water has a tendency to reduce the weight of the fabrics and thus the impact on the sample. The P-Value for the test was 0.0038 (10,259) and therefore, reject the null hypothesis stating there is no difference between the contrast of the shirts and their performance because p is greater than 0.05.

The independent variable of the experiment was the construction of each athletic shirt, and the dependent variable was the performance of the athletic shirt, as defined by each shirt’s ability to absorb water, display it, and get it evaporated in a fast and efficient manner.

The samples were attached using a sprayer gun to more closely match real-world conditions because water has a tendency to reduce the weight of the fabrics and thus the impact on the sample. The P-Value for the test was 0.0038 (10,259) and therefore, reject the null hypothesis stating there is no difference between the contrast of the shirts and their performance because p is greater than 0.05.
We recognize and congratulate these students from North East High School for completing their Capstone projects during extraordinary conditions.

**Honors Biomedical Innovations w/Lab**
Heather Wylie

**Honors Education Academy**
- Madison Blevins

**Honors Engineering Design & Development**
- Michael McGough

**Honors STEM Research & Design Capstone**
- Kaylin Baumiller
- Sarah Doney
- Aidan Fleischhacker
- Luke Hammer
- Rachel Katz
- Trent Khanjar
The creation and testing of a soccer cleat cover to reduce impact force and mitigate the risk of sustaining a subungual hematoma

Summary
Soccer is a known contact sport, so it’s no surprise that many walk away from the field with small injuries. In an effort to reduce said injuries, one can look to the equipment of the players that protect them on the field. The purpose of this project was to create an add-on to a soccer cleat that would decrease the amount of applied force to minimize the risk of receiving a subungual hematoma. The basic idea applied to the external toe cover is that if the amount of material on the top of the cleat increased, it would lower the amount of force on the toes of the player inside of the cleat when stepped on.

The materials used to cover the top of the cleat were Kevlar and were tested on the efficiency of lowering the amount of force the inside of the cleat was exposed to and the effect on control over the ball.
The creation and testing of a soccer cleat cover to reduce impact force and mitigate the risk of sustaining a subungal hematoma

Kaylin M. Baumiller
North East High School

Abstract

Soccer is a known contact sport, so it’s not surprising that many玩家 find themselves on the field with small injuries. In an effort to reduce said injuries, one can look to the equipment of the player that protects them on the field. The purpose of this project was to create an add-on to a soccer cleat that would decrease the amount of applied force to minimize the risk of receiving a subungal hematoma. The basic idea applied to the external toe cover is that if the amount of material on the top of the cleat increases, it would lower the amount of force on the toes of the player inside of the cleat when stepped on. The materials used to cover the top of the cleat were Kevlar and Lycra and were tested on the efficiency of lowering the amount of force inside of the cleat was exposed to and the effect on control over the ball.

Constraints

Constraints throughout this project were:
1. The material need to be flexible and able to bend with the foot as the player ran, kicked the ball, or twisted abruptly.
2. The cover must adhere to the rules and regulations of NCAA and FIFA.
3. The cover can not appear dangerous or endanger the player or another player during game play.
4. The cover can not interfere with the touch of the player or control of the ball during game play.
5. The cover must leave a negative effect on the forest of the soccer cleat.

Methodology

The following was needed to create this experiment:

Design/Construction Stage
- Use chalk to color on the sole. Place the color on the fabric to outline where the stud will be located
- Cut out where the stud would be and overall shape of the cover
- Sew accordingly and attach Velcro
- Design Testing Block
- Ask for and from Construction class to create the Testing Block
- Design and Create Toe Sensor: Add a toe using appropriate sensor and length

Testing Stage:
- Drill a hole through the sole plate of the cleat to allow the force sensor add-on through the top of the cleat
- Test the Toe Cover for force using the force sensor and Testing Block
- Test the Toe Cover for control using a stopwatch

Results

The Kevlar Cover met all of the stated constraints. The design was tested to determine if the cover had an effect on the player’s control of the ball and whether it decreased the force on the ball. The average amount of touches in 30 seconds on the ball with and without the cover were 96.67 touches and 97.33 touches, respectively. The difference is 0.66 of a touch.

The test for force on the cleat, the average force on the cleat after 3 trials for no cover was 1,224.7 N with the cover was 1,372 N. The difference between which is 2.452 N.

Number of Touches in 30 Seconds

![Number of Touches in 30 Seconds](image)

![Force on a Cleat from a Mass Dropped at a Set Height](image)

![Graph displaying the amount of force on the ball after thirty seconds. The averages are included on the end of each graph.](image)

Conclusions

The project was an overall success as an external cover made of Kevlar was created for a soccer cleat that met constraints. While there were attempts in the beginning to use 3D printed covers to create an add-on cover with a 3D printer, it was later proven to be not as strong or durable to last during game play. The Kevlar cover that was produced resulted in a decrease in force against the cleat and no big difference in control of the ball during use. The cover does not look dangerous, does not have a logo, or is created from strong materials that can endanger other players. It is simple to put on while wearing the cleat, although the studs of the cleat can be free of rust.

Despite this, a referee may decide to not allow its use in a game play because of other reasons or personal preferences, so it cannot be determined whether it can be used in all games. However, it may be used as a preventative during practice.

Works Cited


Acknowledgements

Master: Thomas Bellman, Technology and Project Lead the Way Teacher, North East High School
Special Thanks To: Kenny Anne Radziunski, STEM Lead Teacher/Physics Teacher, North East High School
Title  
Teacher Academy of Maryland  
The Future Belongs to Teachers

Summary
Student will be able to complete a rigorous, college-level program that is based on the outcomes of the Maryland Associate of Arts in Teaching (A.A.T) degree, which aligns with the National Council for the Accreditation for Teacher Education (NCATE) standards by exploring Human Growth and Development, Teaching as a Profession, Foundations of Curriculum and Instruction and participating in an Education Academy Internship in a CCPS school.
Teacher Academy of Maryland
Madison Blevins
North East High School

Class of 2020

Topic: The Future Belongs to Teachers

Outcome / Objectives:

SWBAT (Student will be able to) complete a rigorous, college-level program that is based on the outcomes of the Maryland Associate of Arts in Teaching (AA/TT) degree, which aligns with the National Council for the Accreditation for Teacher Education (NCATE) standards by exploring Human Growth and Development, Teaching as a Profession, Foundations of Curriculum and Instruction and participating in an Education Academy Internship in a CCPS school.

Activities:
1. My First Lesson - My first lesson was based upon what I could teach the class using my own knowledge. I decided to do it on counting, but in German. I was always fascinated with other cultures and I took German my first two years of high school. I decided to just do numbers. I opened my lesson with a Warm-Up activity and proceeded with teaching how to pronounce the numbers aloud. After, we did a small worksheet. My first lesson left me very excited when it came to teaching German. I taught my students to understand how to spell the numbers, but also to speak the numbers. I also taught my students how to write the numbers. I was excited to see how my students would respond to my lesson.

2. Baby Project - Upon completing child development we had to care for our own four-babies. I believe mine are a precursors so it was around 1-4lbs. I named my baby Penelope and cared for her for several weeks. During those several weeks we had to feed the baby. I had to learn how to feed the baby every day and have to clean them off that we had to do after each meal. At school we had to clean its bed every day as well.

3. Bulletin Board - For my bulletin board I choose to create it with my friend Jordyn. Our bulletin board had to be presentable along with a craft of some sort. We choose to do sea creatures. The was given the materials to create their version of their favorite sea creature along with giving them names and titles. After the class completed their tasks we presented them to the class. “Let’s Shipboard!” was the month of the year and different sea shells and undersea each student completed and presented their story board on their birthday month. It was fun to see everyone’s creativity in their own creature.

4. Classroom Management Toolkit - My final and favorite project before leaving for internship was designing, creating, and displaying our classroom management items inside of our own toolkit. We had the flexibility to do whatever we wanted as long as we had the materials to do so. I only had to display 7 items from 5 different categories. Categories being Get-To-Know-You, Positive Reflection, Cabinet Items, Negative Reflection, Substitutes Activity, Organizational Supplies, and Tasty Time Filler. My items in my toolkit were a wide variety of items for kids with different needs but mostly contribute to grades under 3rd.

5. Internship - During the month of February we were given the opportunity to intern in a CCPS classroom. I choose 8th Grade with Mrs. Roath at North East Elementary. I loved every minute of it! Mrs. Roath really made me experience great and welcoming as she did the same for her students. During Internship I got the opportunity to observe two grade-level tests, and present three grade-level lessons, but also more for the experience. I also read lots of books for story time and worked one on one with kids who needed extra help. My favorite moments were seeing students bit innovations in their reading and math. Watching that light bulb effect on a student and knowing you taught them that was a cool experience.

Closure:
Upon my completion of the TAM program, I plan to pursue my dream of teaching at Cecil College by doing a dual major in Early Childhood and Elementary Education. When I was in 6th grade my teacher told me she could see me becoming a teacher. When I grew up and from that point on stuck it in my head and pushed me to pursue my dream of becoming a teacher. I am so excited for the future!

Assessment:
I believe that learning patience and how to be a professional in TAM. I learned a lot about myself and that I am a leader, I care for others, and that I am a hard worker. TAM helped me grow into a better version of myself and make lifelong friends that I would have never made had I continued. I learned how to be patient and a professional even when others may not like it. I learned that not everyone is the same and everyone has different ways in which they learn and grow and it still works even if it is a different way than yours. TAM was all I hoped it be and more and I am so thankful I made the decision to be a part of the 2020 class!

Homework:
Attend Cecil College to dual major in Early Childhood and Elementary Education
apply for a job as a teacher at a daycare
Future Goal: Wherever I go, go with all my heart

Acknowledgments:
My Family - Dad, Mom, Lance, Grandparents, Earl, Aunt Amy, Kelly, and particle
Kelly Eddinger - Teacher Academy of Maryland
Tammie, CSOT
Mary Roath - Mentor Teacher, 8th Grade Teacher at NEES
Case Peters - 5th Grade Teacher
Jordyn Keys - Future Teacher
Title  
Modeling and predicting the growth of deep sea mussels on Jupiter’s moon Europa

Summary
Jupiter’s moon, Europa, is theorized to be an ocean world. While an organism dependent on light would not survive under its ice, there is strong evidence for its ocean containing heat and elements like carbon, methane, and sulfur. Some deep-sea organisms, such as the mussels used in this experiment, gain energy from chemical reactions produced by the previous elements in a process known as chemosynthesis.

The purpose of this experiment was to simulate an underwater environment similar to Europa’s and record how long two mussel species, Bathymodiolus thermophilus and Bathymodiolus childressi, could survive, creating an idea of whether life could be found on Europa.
Modeling and predicting the growth of deep sea mussels on Jupiter’s moon Europa

Sarah Doney
North East High School

Abstract
Jupiter’s moon, Europa, is theorized to be an ocean world. While an organism dependent on light would not survive under its ice, there is strong evidence of oceans containing heat and elements like carbon, methane, and sulfur. Some deep-sea organisms, such as the mussels used in this experiment, gain energy from chemical reactions produced by the previous elements in a process known as chemosynthesis. The purpose of this experiment was to simulate an underwater environment similar to Europa’s and measure the growth of two species of mussels (Rbathydiosoma thermophile and Rbathydiosoma chilensis), could succeed, offering an idea of whether life could be found on Europa. The model measured an individual mussel’s saturation (chlorophyll revising hunger), shell growth, tissue growth, health, and chance of death based on temperature and iterated over time in weeks. 60 trials were taken in total, for each species and temperature range combination. Most mussels reached maximum shell length and mass by the 3rd week, though some lingering at higher temperatures lost size and mass. Overall, both species survived best at the lower temperature ranges, and every range except for the highest range of temperatures had at least one 10-week trial.

Methodology
Prior to the experiment, research between Earth and Europa
Temperature of Europa’s ocean
Hydrothermal vent
Possible variables in ice
Relationships between these variables
Species to be used in experiment
 Mussel, tapeworms, helminths, and bacteria were all considered
Size, husband, growth rates, and limits of species
Temperature range
The following was completed as preparation for the experiment:
- Graphing testing variables over time
- Determined growth rate data to be more efficient for model’s purpose
- Created model
  - Initialized temperature and calculated rest of variable values at time 0 (shell length was randomized from set range of min-max, tissue growth was calculated from the information of previous variables)
- Climaxed shell length
  - Calculated (linear over time in weeks, randomized temperature in certain testing variables calculated from graphs over temperature, shell length and tissue calculated using growth rate graph)

Results
- Survival, health, and chance of death: stayed in a safe range for most trials
- Reproduction: survival in either relatively flat or increasing, implying that mussels were able to retain energy over time.
- Despite some trials resulting in the species failing to develop (T & C Below), the average saturation never went below 30%
- In all temperature ranges, mussels that survived 2-3 weeks generally reached maximum shell length.
- In the highest temperature range (T & C Small), there were multiple instances of the shell and tissue shrinking.
- Both species maximum mass in the order of low temperature, medium temperature, and high temperature.
- Despite the chance of death decreasing over time for Rbathydiosoma thermophile & Rbathydiosoma chilensis at small radius, neither survived for more than 6 weeks.
- The death rate of both species was due to the temperature being initialized at a very high value, which pushed the average much higher than it would be if only included the trials that lasted multiple weeks.

Conclusion
The purpose of this project was to help predict whether life could exist on Jupiter’s moon, Europa. After analyzing the results from these trials, it is clear that the temperature of the moon would not prevent life from existing on Europa.
Overall, the average saturation never fell below 30%. This means that even at low temperatures, the species was able to retain energy. In the highest temperature range (T & C Small), there were multiple instances of the shell and tissue shrinking. This is explained by metabolic depression. Metabolic depression would lead to starvation or malnourishment, potentially causing the tissue to lose fat and the shell to weaken and break apart. All other species reached maximum shell length around the same time, implying that the growth rate is not impacted by temperature. Tissue mass was more spread out; both species reached maximum mass in the order of low-medium-high. Tissue growth was dependent on temperature as one of its main components is fat and it fluctuates in quantity due to stress. Adding more independent variables such as available nutrients, water currents, and chemical energy would make the simulation more realistic and improve the experiment. Growth rates of both species should also be researched further to make the model more accurate.

Background
Europa, one of Jupiter’s 79 known moons, is theorized to be an ocean world—a colossal body harboring a significant amount of saltwater. The ice covering the surface is around 5-25 km thick, but the ocean itself would be 60-130 km deep. While no probes have landed on the surface of Europa yet, multiple fly-bys have gathered information about conditions on and below the ice, like proof for sodium chloride deposits and hydrothermal vents.9 Due to its distance from the sun, as well as the fiction of its icy plumes, ice is possible. Organisms would need to use chemosynthesis—a method of creating energy using chemical reactions from inorganic elements. The organisms chosen for the experiment, Rbathydiosoma thermophile and Rbathydiosoma chilensis, are deep-sea mussels that use chemosynthesis for energy.

Other than energy, life would also need the right amount of heat and pressure to exist on Europa. The water temperature would be colder than Earth’s due to the presence of ice covering the freezing point, but deep-sea mussels naturally live in cold temperatures. Additionally, proof has been discovered for hydrothermal vents, a very efficient source of heat for deep-sea mussels.4 As for depth, it is balanced out by Europa’s lack of gravity; one unit of Earth.

Like Europa, most topics in astrophysics can’t be explored through physical experiments. Computer modeling allows for normally huge expensive, and/or currently impossible physical experiments to be held on a small, manageable scale. These models are generally created using mathematical relationships between variables to simulate changes over time. They won’t be as accurate, but they give a good estimate for what will happen in a physical experiment.

Citations
1. bibliographic entry 1
2. bibliographic entry 2
3. bibliographic entry 3

Acknowledgments

Special Thanks To: Kerry Anne Kozadzinski, STEM Lead Teacher/Physics Teacher, North East High School

Figure 1  - graphs of each dependent variable over temperature for 8, 3, 3 classes. These functions were used to calculate the values for the computer model.

The following steps were completed as preparation for the experiment.
- Run 10 trials for each temperature range/species, ended with 60 total
- Standard data to vectors
- Graphed averages of each variable for each temperature/species combination and temperature range.

Figure 2  - A NASA of Jupiter’s moon Europa with a closeup of the ‘ice canals’ on the moon.

Figure 3  - The average saturation over time. Each line represents a combination of mussel species and temperature range. From top to bottom, faster, more, and most, and mass small radius for both species.

Figure 4  - The average shell growth over time. Each line represents a combination of mussel species and temperature range. From top to bottom, faster, more, and most, and mass small radius for both species.

Figure 5  - Rbathydiosoma thermophile
Figure 6  - Rbathydiosoma chilensis
Aidan Fleischhacker
Grade 11
North East High School

Title  The design and programming of the autonomous pin board for elevation modeling (APEM)

Summary
The goal of this project was to integrate elevation values from the Google elevation API and represents those values on a pin board. The result was a scaled 3D image of real-word topography on the pin board. The system uses a set of pulleys controlled with motors using CoreXY theory to move a servo motor around and individually push up the pins on the board until the design is created.
The design and programming of the autonomous pinboard for elevation modeling (APEM)

Aidan Fleischhacker
North East High School

Abstract

The goal of this project was to integrate elevation values from the Google elevation API and represent these values on a pinboard. The result was a scaled 3D model of the earth's surface on the pinboard. The purpose was to create a physical simulation of the earth's surface using the Google elevation API and represent these values on a pinboard. The result was a scaled 3D model of the earth's surface on the pinboard. The purpose was to create a physical simulation of the earth's surface using the Google elevation API.

Constraints

The constraints of the project area are as follows:

- The project must use real-world elevation data.
- Time availability for the project.
- The project must be completed within a certain timeframe.

Background

3D printing has exploded into our modern society. Today people can print everything from gears to models to even to mechanical fasteners. 3D printing has transformed the way we think about manufacturing and design. This project is a great example of one such transformation. This project uses the CoCo3D library to represent the earth's surface on the pinboard. The CoCo3D library is an open-source 3D graphics library that can be used to create 3D models and animations. This project is an excellent example of how 3D printing can be used to create a physical representation of the earth's surface.

Materials

- A Raspberry Pi
- 3D printed model
- Various 3D printed parts
- Various electronic components
- Various software tools

Technical Methodology

The overview of this project is as follows (note that all GPD6 pins are used unless otherwise specified):

- Connect the power source to the Raspberry Pi to power it up.
- Connect the power source to the 5V GPD6 pin on the Raspberry Pi.
- Connect the power source to the GPD6 pin on the Raspberry Pi.
- Connect both limit switches to the 5V GPD6 pin and ground them to 5V open/GND pin.
- Find the power source to the limit switch on the Raspberry Pi and connect it to the 5V open/GND pin.
- Attach wires between each of the diameter and the limit switch to the GPD6 pin on the Raspberry Pi.
- Connect the 3D printed model to the limit switch on the Raspberry Pi.
- Connect the 3D printed model to the GPD6 pin on the Raspberry Pi.

To create a topographical map on the pinboard, the 3D printer uses the Google elevation API and makes 3D models for elevations in a rectangle of the same proportions as the pinboard. With this data a CSV file is created, saved, and transferred to the Raspberry Pi using a USB stick.

Once loaded, a second Python program on the Raspberry Pi populates the data of the pinboard. The program populates the data of the pinboard. The program populates the data of the pinboard.

Conclusions

This project was a great opportunity for the design and programming of the autonomous pinboard for elevation modeling (APEM). The APEM meets the requirements of many students by allowing them to create a physical representation of the earth's surface.
Title  
A study of techniques for improving the removal of potential pathogens from indoor turf

Summary
In today’s modern era, many athletic complexes are making the switch from regular grass to artificial turf. This switch over trend has created several new concerns for the care and maintenance of the turf for its longevity. One of the biggest concerns is the cleaning of the turf to prevent the growth and transfer of bacteria.

The purpose of this project was to test current cleaning methods for artificial turf in order to determine if a better cleaning method can be developed. A section of artificial turf was inoculated with *staphylococcus aureus* and allowed to grow for 48 hours. Each section of turf was cleaned are resampled. The cleaned sample with the fewest bacterial colonies or smallest area of growth were deemed the most effective.
A study of techniques for improving the removal of potential pathogens from indoor turf

Luke Hammer
North East High School

Abstract
In today’s modern era, many athletic complexes are using the switch from regular grass to artificial turf. This switch over trend has created several new concerns for the care and maintenance of the turf for its longevity. One of the biggest concerns is the cleaning of the turf to prevent the growth and transfer of bacteria. The purpose of this project was to test current cleaning methods for artificial turf in order to determine if a better cleaning method can be developed. A section of artificial turf was inoculated with Staphylococcus aureus and allowed to grow for 48 hours. Each section of turf was cleaned and resampled. Samples from the cleaned turf were grown and analyzed. The cleaned sample with the fewest bacterial colonies or smallest area of growth were deemed the most effective.

Background
Around the world, athletic complexes are adapting to the modern era. They are switching over from using grass to artificial turf. Artificial turf is a very versatile flooring for these types of complexes because it can deal and work under unexpected weather conditions and various climates. One of the biggest challenges that is facing facilities with artificial turf is its cleaning. Most dirt and debris can be washed away by hosing down the turf. However, the turf is an ideal environment for many of these pathogens. Most of these pathogens are not easily washed away by water. Therefore, ensuring that pathogen are not left on the turf after cleaning is a lot more difficult.

One of the more common infections bacteria found on many surfaces is Staphylococcus aureus. This bacteria can cause everything from skin rashes to severe skin lesions. This was the rational behind the use of Staphylococcus aureus in the testing phase. It is important to control this bacteria on all surfaces but especially on surfaces in which players may have broken skin or injuries.

Materials
- Nutrient Agar Powder
- Distilled Water
- Hot Plate
- Magnetic Stirrer
- Petri Dishes (15mm)
- Refigerator
- 600mL Beaker
- Electronic Scale
- Plastic Boats
- Square of Artificial Turf
- Utility Knife
- Staphylococcus aureus
- Borax
- Bleach
- Lysol Wipes

Turf Testing Procedure
The following procedures were used to inoculate, clean, and sample the pest cleaned turf:
1. Use a sterile cotton swab to sample some Staphylococcus epidermidis from the stock plate.
2. Apply the stock on the cotton swab to the selected turf sample by rubbing the swab across the turf.
3. Incubate the turf sample for 48 hours to allow the Staphylococcus epidermidis to propagate.
4. Prepare a new nutrient agar plate by drawing a line down the center of the back. Label one side ‘before cleaning’ and the other side ‘after cleaning’.
5. In addition, label the name of the cleaning being used in the specific trial to in progress.
6. Sample the sample before cleaning by running a sterile swab across the turf 20 times.
7. Incubate the agar plate with the swab on ‘before cleaning’. Be sure to use a thoroughly apply it to only the one side.
8. Measure out 10 ml of the selected cleaner. Apply the cleaner to a sterile paper towel.
9. Use the paper towel to clean the turf by applying moderate pressure and rubbing the turf in a circular motion 20 times.
10. Wait 10 minutes after cleaning for the turf to dry.
11. Sample the turf after cleaning by running a sterile swab across the turf 20 times.
12. Incubate the agar plate with the swab on ‘after cleaning’. Be sure to use a thoroughly apply it to only the one side.
13. Place the agar plate in the incubator for 48 hours.
14. Remove the agar plate from the incubator and place it on a 1cm x 1cm graphing paper.
15. Take a picture of the plate and calculate the area of the staff growth on both sides.
16. If possible, count the number of colonies on both sides.
17. Repeat these procedures for each of the cleaners in this study.
18. The cleaner with the smallest number of colonies and the smallest area is the most effective cleaner.

For Further Exploration
Due to the circumstances beyond the researcher’s control, no trails were completed in this experiment. However, this experiment is something that would have directly impacted North East High School. The results could have been used to help direct maintenance of the artificial turf field at the school.

With additional time, the researcher would like to:
1) Complete the basic cleaning trails. 2) Modify the application process of the cleaner to the turf with the most effective cleaner to determine if application is a variable in the experiment. 3) Change the application time of the most effective cleaner to determine if time is a variable in the experiment. 4) Analyze all of changes in variables and determine which is the most effective.

References

Acknowledgements
Mentor: Kerry Anne Kedzierski, STEM Lead Teacher/Physics Teacher, North East High School
Title  
The effects of various wooden instrument-cleaning methods on *Staphylococcus epidermidis*

Summary  
Music and art education are more important now than ever, and as this trend grows, more students are taking to playing musical instruments. Going along with this uptick in musical education, instrument hygiene becomes of the utmost importance.

The initial purpose of this project was to determine potentially effective methods of cleaning the surface of a stringed instrument. The experiment focused mainly on a violin bow, rather than other parts of the instrument. The bow was swabbed with *Staphylococcus epidermidis* and was then treated with several different cleaning solutions in order to determine the one that was most effective at killing the bacteria.

The method that was considered to be the most effective was the one that had the fewest bacterial colonies after the solution was applied compared to before the solution was applied.
The effects of various wooden instrument-cleaning methods on *Staphylococcus epidermidis*

Rachel L. Katz  
North East High School

**Abstract**

Music and art education are more important now than ever, and as this trend grows, more students are taking to playing musical instruments. Going along with this uptick in musical education, instrument hygiene becomes of the utmost importance. The main purpose of this project was to determine potentially effective methods of cleaning the surface of a stained instrument. The experiment focused mainly on a violin bow, rather than other parts of the instrument. The bow was swabbed with *Staphylococcus epidermidis* and then treated with several different cleaning solutions in order to determine the one that was most effective at killing the bacteria. The method that was considered to be the most effective was the one that had the fewest bacterial colonies after the solution was applied compared to before the solution was applied.

![Image](image1.png)

**Background**

Starting as early as elementary school, students begin learning how to play musical instruments. However, while lots of information exists regarding the proper techniques to clean wood instruments, there remains little regarding a technique for cleaning stained instruments. The improper cleaning of a stained instrument could lead to increased bacterial growth on the surface of the instrument. This bacterial growth presents health hazards to the player and potential damage for the life of the instrument.

Typical violins and other stained instruments are created with a layer of varnish on the outside of the instrument that helps to seal and protect its surface. This layer of varnish, however, is usually very thin and gets a restriction on the types of cleaning methods that could be used to clean the surface of the instrument. For purposes of the experiment, bleach or any other harsh cleaners were not used because they would likely strip the instrument of its varnish and could potentially stain the color of the wood.

Different parts of the instrument are made from different materials, and different methods are needed to clean each surface. Some parts can be stainless steel, fiberglass, etc., but for the purposes of this experiment, only wood-cleaning methods were used, as wood comprises most of the instrument.

**Methods**

The following steps were implemented in order to carry out the experiment:

- All materials were sterilized and sterile procedures were following through the experiment.
- Poor agar was used to prepare 12 sterile petri dishes.
- A sterile pipette was taken from a sterile tube using an inoculation loop and applied to a sterilized petri dish.
- The stock plate was incubated at 37 degrees Celsius. A stock source was maintained throughout the entire experiment.
- Plates were marked with name, date, time, and cleaning method, lines were drawn down the middle of the plates to denote “before” and “after.”
- Small lines were drawn on the bow to separate it into sections; sections were labeled with the cleaning method that was to be used.
- The *S. epidermidis* was applied from the stock plate onto each section of the violin bow using a cotton swab.
- All parts of bow were swabbed again and applied to individual plates on the “before” section.
- All cleaning methods were applied to a section of the bow using a sterile towel.
- All parts of bow were swabbed again and applied to the same plates on the “after” section.
- All sample plates were incubated at 37 degrees Celsius.
- A half and half water mixture was used to sterilize the bow and all other materials.
- After 48 hours of incubation, plates were removed.
- If possible, the number of bacterial colonies that existed before and after cleaning were counted and measured in size.

This data was used to determine the most effective method.

**Data**

Vinegar, hydrochloric peroxide, and vinegar-disinfectant solution were the most effective methods that were selected for further testing.

**Conclusion**

The purpose of this experiment was to find an effective method for cleaning the surface of a violin. Hydrogen peroxide, vinegar, and a vinegar-disinfectant solution were all used to combat *Staphylococcus epidermidis* in an effort to see which one was the most effective. Out of the three cleaning methods, vinegar appeared to be the most effective as it had the fewest bacterial colonies in the “after” portion compared to the “before” portion. However, each of the three solutions did seem to work to some extent.

Due to the circumstances under which this experiment was conducted, only one trial was able to occur for each of the different cleaner types. If further research were to occur, it is entirely possible that with just these cleaners, other outcomes than the one demonstrated here may have been shown. Additionally, because of the circumstances, no surfaces on the instrument other than the violin bow were able to be tested. Because the functional areas of all other surfaces are just as important to the hygiene of the instrument as the bow, further research would also be beneficial in these areas.

**Works Cited**


**Acknowledgements**

Mentor: Charlotte Miller, BSN, RN, Infection Preventionist, ChristianaCare, Union Hospital

Special Thanks to Katie Anne Kadziolka, STEM Lead Teacher/Physics Teacher, North East High School
Title  The design, prototyping, and testing of an ankle brace that mitigates ankle strain experienced while using swim fins

Summary
Swim fins, or flippers, are used by divers, athletes, tourists, and distance swimmers to increase their swimming speed and duration. Unfortunately, lower leg pain has been associated with the use of swim fins by amateurs with less developed muscles in the leg areas that are highly utilized while using fins.

This project asked the following question: Can a simple, cheap brace be used to reduce the strain that swimming with fins places on the lower leg?

The purpose of this project was to modify and test an ankle brace to be effective in supporting the ankle of an inexperienced fin swimmer. The main constraint of the project was to reduce the force in both vertical directions, in an effort to reduce hyperextension and subsequent muscle damage.

Tests were conducted against a control group (without a brace) by measuring a bungee cord supporting the flipper as weight is added to the foot.
The design, prototyping, and testing of an ankle brace that mitigates ankle strain experienced while using swim fins

Trent Khanjar

North East High School

Abstract

Swim fins, or flippers, are used by divers, athletes, tourists, and distance swimmers to increase their swimming speed and duration. Unfortunately, lower leg pain has been associated with the use of swim fins by amateurs with less developed muscles in the leg areas that are highly utilized while using fins. This project asked the following question: Can a simple, cheap brace be used to reduce the strain that swimming with fins places on the lower leg?

The purpose of this project was to modify and test an ankle brace to be effective in supporting the ankle of an inexperienced swimmer. The main constraint of the project was to reduce the force in both vertical directions, in an effort to reduce hyperextension and subsequent muscle damage. Tests were conducted against a control group (without a brace) by measuring a bungee cord supporting the flipper as weight is added to the foot.

Background

Fin swimming is common across different areas of activity, used both as an activity in and of itself and as a training tool for athletes. Tourists, divers, and distance swimmers use flippers for snorkeling, scuba diving, or to cross long distances in a shorter time. Runners and swimmers use them to build their leg muscles.

If someone uses swim fins without first properly building those areas of muscle, painful, long-term injury can occur as the anterior tibialis is overworked. These injuries can lead to everything from issues during a vacation to long-term damage. However, these injuries on the lower leg muscles can be prevented. Extra support on the ankle will provide increased resistance to vertical movement. This is essentially serves as a crutch for less developed muscles to avoid hyperextension and strain.

The project keys this idea by looking to create an integrated brace and fin. The target users of this new design are amateur fin swimmers looking to develop their legs in order to prevent injuries.

Constraints

The following constraints were applied to the prototypes of the project:

- The brace must reduce the upwards and downwards force sustained by the ankle joint
- The brace must be comfortable to wear
- The brace must fit inside of a swim fin

Prototype

The prototype for the project was created from an A4/C5 paper brace and strips of elastic string.

Methods

The following procedures were preformed to test the function of the swim fin in the absence of a force sensor:

- Attach brace to one ankle of a model skeleton
- Put swim fin on model skeleton's foot
- Attach flipper to wall using a bungee cord, cord is taut but not stretched
- Add weight to the foot
- Measure bungee cord
- Compare with control

For the downward force the skeleton was upright and the bungee cord was attached to the wall near its pelvis, and for the upward force the skeleton was suspended upside-down and the bungee cord was attached to the wall above the foot.

Results

Compared to the control, the brace was at least slightly effective in reducing the force on the ankle joint. The brace was more effective in reducing downward force than upward force.

<table>
<thead>
<tr>
<th>Test</th>
<th>Control</th>
<th>Brace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance on bungee</td>
<td>85.3 cm</td>
<td>81.3 cm</td>
</tr>
<tr>
<td>Charge to detection</td>
<td>0.2 cm</td>
<td>0.8 cm</td>
</tr>
</tbody>
</table>

Conclusion

This project did have success as it met several of the constraints. It's main success was in the reduction of force on the ankle joint as compared to a control. Therefore, constraint of reducing the amount of force on the ankle was met. The constraints of comfort and fit were also met, as the brace was not uncomfortable and did fit inside of the swim fin.

The project's biggest failing was in the testing area. This is due to the fact that all of the testing was performed without the aid of more scientific tools. The data cannot be interpreted further than “it worked a little bit” because the spring constant for the bungee cord used is unknown.

Given more time and resources, the first priority would be to conduct more scientific testing on the prototype. After this, the project would be enter a cycle of redesign and retesting until optimization.

Works Cited


Acknowledgements

Mentor: Timothy Hildebrand, LAT, AFC, Athletic Trainer, ATI Physical Therapy

Special Thanks To: Frank Cardo, Program Coordinator for Science, STEM & Environmental Science. Cecil County Public Schools

Special Thanks To: Kerry Anne Kedzierski, STEM Lead Teacher/Physics Teacher, North East High School
Title  The Waterproof Cast Sleeve

Problem statement
Many medical patients in America who have to wear cast for their injuries agree that, despite the newest innovations and high cost of casts, water damage to a cast can cause significant inconvenience and irritation.

Statement of purpose
The purpose of our team is to develop a system that can effectively prevent water from coming into contact with a patient’s cast and compromising the casts structure. We want to develop a product that effectively prevents water damage to the cast and allows for the use of fingers so that the user can still swim and shower with ease.

What we did to solve this
We decided to make a waterproof cast sleeve to go over the cast provided protection from water.
The Waterproof Cast Sleeve
Michael McGough
PLTW EDD North East Maryland High School

Introduction

Problem statement- Many medical patients in America who have to wear cast for their injuries agree that despite the newest innovations and high cost of casts, water damage to a cast can cause significant inconvenience and irritation. According to a survey taken by students in the surrounding area, many students who had previously worn a cast stated that the lack of waterproof abilities in their casts have negatively affected their ability to shower and swim at lakes, pools, and beaches.

Statement of purpose- The purpose of our team is to develop a system that can effectively prevent water from coming into contact with a patient’s cast and compromising the casts structure. We want to develop a product that effectively prevents water damage to the cast and allows for the use of fingers so that the user can still swim and shower with ease.

What we did to solve this- We decided to make a waterproof cast sleeve to go over the cast provided protection from water.

Methods used

How we decided our choice- Our team made three different designs. The first is a waterproof sleeve with padding on it to provide extra protection. The second is a cast sleeve made of Gore-Tex making it breathable. The third is a two part system which is cheaper to make. At first to help us make a decision. We made a decision matrix to sort out what idea is the best. With the matrix it came out to be option three and close behind was the second. Then we decided to make a survey to the public to see what the public would want. The public choose option two. We decided to go with the option two as the best way to make the most money and would do the best on the market.

Materials used

How we decided our materials- To decided that we need to have Gore-Tex fabric and three elastic bands and thread to help sewing. To choose what type of band and thread and what brand to go with we compared prices and decided on some brands on the cheapest price but not the cheapest quality.

The Market

How we studied the market- We looked at competition and looked to see were we can improve. Most of the designs were baggy and the seal wasn’t good. Also the designs didn’t have places for your fingers. So to improve we decided to make a stronger seal, make the sleeve tighter, and make there spots for your fingers. We also saw the prices of the sleeves and decided to try to make the sleeves cost less to help beat the competition.

Conclusion

We were never had a chance to actually test the sleeve design as Gore was in a way closed so we weren’t able to obtain the Gore-Tex to make the cast sleeve. But at the end of the day we feel like we came up with an idea to stop water damage in cast while making the sleeve breathable.
Title  Do certain spices have antibiotic effects on bacteria?

Summary
Spices and herbs are used all over the world, they help to add flavor but may be useful for other reasons as well. Herbs are the edible part of the plant that comes from the leaves and spices are the part that comes from the non-leafy parts. One of the more common uses is to use different kinds of spices and herbs is on raw meat, however raw meat is known to carry harmful bacteria that can infect and damage the body. This is important, because if the spices and herbs that are exposed to the bacterial growth decrease growth as the spice level goes up, we can reasonably assume that spices play a role in not only flavor but killing bacteria. Although the bigger picture through a societal perspective is how these everyday spices and herbs are helping us.
Do certain spices have antibiotic effects on bacteria?

Heather Wylie

PLTW Biomedical Sciences, Cecil County School of Technology

Introduction
Spices and herbs are used all over the world, they help to add flavor but may be useful for other reasons as well. Herbs are the edible part of the plant that comes from the leaves and spices are the part that comes from the non-leafy parts. One of the more common uses is to use different kinds of spices and herbs is on raw meat, however raw meat is known to carry harmful bacteria that can infect and damage the body. This is important, because if the spices and herbs that are exposed to the bacterial growth decrease growth as the spice level goes up, we can reasonably assume that spices play a role in not only flavor but killing bacteria. Although the bigger picture through a societal perspective is how these everyday spices and herbs are helping us.

Materials and methods

<table>
<thead>
<tr>
<th>Bali</th>
<th>Measuring spoons and water and put on hot plate for 10 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolt</td>
<td>Measuring spoons and water and put on hot plate for 10 minutes</td>
</tr>
<tr>
<td>Incubate</td>
<td>Measure out spice extract using a micropipette and add water</td>
</tr>
<tr>
<td>Mix</td>
<td>Measuring cup and water to mix the spices and herbs</td>
</tr>
<tr>
<td>Plate</td>
<td>Measuring cup and water to mix the spices and herbs</td>
</tr>
<tr>
<td>Grow</td>
<td>Incubate the dishes</td>
</tr>
</tbody>
</table>

Results

From my results, I found that garlic killed the most raw meat bacteria. I had also previously used between 50-150 micrometers of spices in a bag, which showed little to no results compared to the control. For this reason, I decided to decrease the amount of spices in each dish from 200-2000 mg. (Fig. 1). From this, the bacteria that grew on the dishes decreased significantly as the garlic increased.

Figure 1. The spice used in this trial was garlic. Garlic was chosen because it had shown the most promising in previous trials when using 50 micrometers of spice extract. Anything beyond the 2000 mg. of garlic would not work.

Figure 2. As you can see in the control plate is almost completely covered; however, the plates with 200 micrometers of garlic extract has half the growth of the other.

Figure 3. In these three dishes there is 800, 900, and 800 micrometers of garlic extract has even less growth than the dishes with 200 micrometers.

Figure 4. The 1000 and 2000 micrometers of spices did not grow at all although it was incubated. I found that 2000 was the maximum amount of spices that could be put into the dish before it would not grow.

Figure 5. These were the spices I used throughout the project: spicy, cayenne, garlic, cumin, sea salt, bay leaf, chile. Although we were more than others for the sake of time.

It would have been better to observe if the concept of all raw meat bacteria decreased with all spices; but I only had enough time to test the garlic as we have the only one with a visible difference in the smaller trials. Doing further experiments would be useful to map out if the spices acted on a curve, like an enzyme under pH. It is also possible that the spices work just as well as the garlic they just need to be cut in different concentrations or are beneficial in ways we cannot see just by putting them on plates. On that they work better or worse with others. Because I had to change my experiment after I had done my research. I don’t have as many facts but if I had another chance I would focus on the other spices more too.

Conclusions

From this data, we can conclude that in these circumstances, the garlic did decrease the growth of the raw beef bacteria. Because both the meat and the spices were extracted in water it would not be very accurate to assume the exact ratio of spices to actual food. However, it is reasonable to suggest that this could potentially set as a preservative so that we can limit the damage from infection, and also limit the use of chemical preservatives. Preservatives are becoming more and more common in the foods we eat today and some alternatives, like spices, may be a good idea to look into.

Although realistically the garlic was the only spice used to convey most of the results due to time, further studies would be necessary to look into other spices as well, to see what best they grow, when more extract is used.

Acknowledgements

I would like to thank Cecil County Public Schools and Cecil County School of Technology specifically Mr. Tassell, Mr. Dinsmore, Mr. Dine, Mr. Mire and Mrs. Payne for making this project possible. As well as my Biomedical Sciences instructor, Wendy Palmieri and my mentor, Kevin Brown for helpful advice and encouragement.

Literature cited

Babesian, T., & Schn., B. (2018). Basic Tulsa: Biomedical Sciences, University of Tulsa.

For further information
Please contact test-my@email.com
PERRYVILLE
HIGH
PERRYVILLE HIGH SCHOOL

We recognize and congratulate these students from Perryville High School for completing their Capstone projects during extraordinary conditions.

<table>
<thead>
<tr>
<th>Honors Engineering Design &amp; Development Capstone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brayden Adkins</td>
</tr>
<tr>
<td>Teno Christofano</td>
</tr>
<tr>
<td>Samantha Copenhaver</td>
</tr>
<tr>
<td>Edward Hanssen III</td>
</tr>
<tr>
<td>Caleb Phillips</td>
</tr>
<tr>
<td>Nicholas Romano</td>
</tr>
<tr>
<td>Andrew Wennersten</td>
</tr>
<tr>
<td>Andrew Wennersten</td>
</tr>
<tr>
<td>Dylan Whitney</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Honors PLTW Biomedical Sciences Capstone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunter Arledge</td>
</tr>
<tr>
<td>Emma Biddle</td>
</tr>
<tr>
<td>Jordan Carr</td>
</tr>
<tr>
<td>Chloe Clarke</td>
</tr>
<tr>
<td>Alida Coggins</td>
</tr>
<tr>
<td>Tyler Corcoran</td>
</tr>
<tr>
<td>Ashlin Dohler</td>
</tr>
<tr>
<td>Kay Dumont</td>
</tr>
<tr>
<td>Mariana Ercole</td>
</tr>
<tr>
<td>Madison Harrah</td>
</tr>
<tr>
<td>Cora Hickling</td>
</tr>
<tr>
<td>Grace Hutchinson</td>
</tr>
<tr>
<td>Michael Olszewski</td>
</tr>
<tr>
<td>Nicholas Peterson</td>
</tr>
<tr>
<td>Elizabeth Rovine</td>
</tr>
<tr>
<td>Isabella Simon</td>
</tr>
<tr>
<td>GraceHope Stevens</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Honors STEM Research &amp; Design Capstone</th>
</tr>
</thead>
<tbody>
<tr>
<td>James Lewis</td>
</tr>
<tr>
<td>Leah Morgen</td>
</tr>
<tr>
<td>Andrew Wennersten</td>
</tr>
<tr>
<td>Andrew Wennersten</td>
</tr>
<tr>
<td>Dylan Whitney</td>
</tr>
</tbody>
</table>
Title  Fire Sprinkler and Suppression

Summary
The idea of this product is to get more people to install sprinkler systems within their houses by eliminating some of the common problems that people have with the normal sprinkler systems. For example, the extinguisher lays a blanket of foam on top of the fire which takes away the oxygen and shrinks the fire.

This extinguisher is not only just as effective as water, but it is easier to clean up and causes less amount of damage to the house. With a water sprinkler a lot of people deal with more money in water damage then actual fire damage. This system would also be cheaper and you wouldn't have to lay pipes all throughout the ceilings of your house. This products would hopefully get people to install some sort of sprinkler system within their houses which would slow the death rates of people in house fires.

Brayden Adkins

Grade 12
Perryville High School

Honors Engineering Design & Development
Teacher: Daniel Kiesl
Fire Sprinkler and Suppression
Samantha Copenhagen, Brayden Adkins
Honors Engineering Design and Development, Perryville High School

Introduction
The number of fatalities from house fires are on the rise. Many people have experienced problems with their traditional sprinkler system or they do not have the money to put the sprinklers in their house. Our goal is to reduce the amount of human contact that is needed to put out a fire. This will allow people to get out of the house faster when they are not worried about trying to put the fire out themselves. Many fire safety companies have collected statistics on house fires. These statistics include how they start, and how many people average a fire a year in these. Companies will talk about the flaws of sprinklers like pipes freezing, the amount of water damage that is caused from the sprinkler, in some cases the sprinkler have not worked or worked effectively. We will test our project based on if the fire is reduced in size, and to keep the fire contained. We will use concepts like chemical compounds, math formulas, and controlled systems. We will need to gain access to basic sprinkler heads, and materials to mold new sprinkler heads to work with our designs. For these designs are plan to take ideas from the patented ideas to make them work better and more effectively.

Materials and methods
If we were able to put out the school yard and finish our project the goal was to create a sprinkler that would work directly. This would use a fire extinguisher and a normal sprinkler head. The fire extinguisher would allow for it to be easily changed, and also customizable to the area or room that this would be installed in.

These images are the standard items that we were planning on using in our design and prototype in order to make our design functional and affordable.

Benmarks to Be Tested on
Does it put out the fire?
Does it slow the growth of the fire?
How fast does it react to the fire?

Testing
We are going to test our sprinkler systems on two major categories. These two categories are that the fire has been reduced in size and can be completely out the fire. Most importantly it would be tested to make sure it work accurately and can be reliable. This is because it is not often that you would have a house fire, but in the event that you did you need to know that you have a reliable system that is going to work.

Marketing
This product would be a more affordable option compared to the normal sprinkler systems. With a normal sprinkler system you have to pay a lot up front in order to get all of the pipes installed throughout the house or building. With this system there would be no pipes just the extinguisher canister hooked up to the sprinkler and which activated would be sprayed on the fire. This product would also be customizable per room it is in. For example you would see a different extinguisher for a kitchen then a bedroom. It would even reduce the amount of water damage done in a house when a small fire occurs.

Ideal when we would test our prototype we would have a controlled burn box outside and using the same material seeing which system (a normal sprinkler system or our extinguisher version) would put out the fire the fastest. Also, we would be watching to see if it would keep the fire under control or if it put out completely and keep it out.

Concepts Used:
Some of the concepts that will have to be used within our designs are going to be volume formulas, chemical compounds found within the fire extinguisher, and the ways or water or the chemicals in the extinguisher will reach with specific fires (chemistry), pal, containment, a heat system and control systems. These are all math, science, and engineering that we will have to use and keep in mind throughout our prototyping and testing.

Conclusions
In conclusion, the idea of this product is to get more people to install sprinkler systems within their house by eliminating some of the most common problems that people have with the normal sprinkler systems. For example, the extinguishing agent is a blast of foam on top of the fire which takes away the oxygen and drains the fire. This extinguisher is not only just as effective as water, but it is easier to clean up and causes less amount of damage to the house. With a water sprinkler or any people deal with unnecessary more money in water damage than actual fire damage. This system would also be cheaper and you wouldn’t have to lay pipes all throughout the ceilings of your house. This products would hopefully encourage people to install some sort of sprinkler system within their houses which would slow the death rates of people in house fires.

Literature cited
Title  The Effect of Antibiotics Produced by Bacillus subtilis On the Growth of Escherichia coli

Summary
In this investigation there are two bacteria that are being used which are Bacillus subtilis (B. subtilis) and Escherichia coli (E. coli). B. subtilis has the ability to produce antibiotics when in competition to grow with or against other bacteria.

These antibiotics can kill both gram negative and positive bacteria, allowing B. subtilis to almost always win the fight with other bacteria. E.coli is a common enterobacteria that helps in the digestion of food. Both bacteria can be found in myriad environments and even the human body. B. subtilis is in many probiotics which help improve bodily functions.
The Effect of Antibiotics Produced by *Bacillus subtilis* on the Growth of *Escherichia coli*

Hunter Arledge

PLTW Biomedical Science Program, Perryville High School

**Abstract**

In this investigation there were two bacteria that are being used which are *Bacillus subtilis* (B. subtilis) and *Escherichia coli* (E. coli). B. subtilis has the ability to produce antibiotics which can inhibit the growth of other bacteria. *Escherichia coli* is a common bacterium that helps in the digestion of food. Both bacteria can be found in natural environments and even the human body. B. subtilis is in many prokaryotes which help suppress bodily functions. The researchers will be using E. coli E.coli into a lab and the bacteria into a growth chamber. The experiment will be performed by using B. subtilis to prevent E. coli from growing in a growth chamber.

**Introduction**

- *Bacillus subtilis* and *Escherichia coli* are bacteria that are found in a myriad of environments. *E. coli* can also be found within animals, including the human digestive system where it helps the body break down and digest food.
- Though *B. subtilis* is not commonly found in humans, it is a component of probiotics consumed by humans (1) where it is used as a probiotic to help in the treatment or prevention of gastrointestinal disorders.
- *B. subtilis* is unique in that it has the ability to produce polymyxin, dextran, subtilin, and mycolysin which are antibiotics. These antibiotics are secreted during sporulation to increase the competitiveness of *B. subtilis* in food. These antibiotics can produce different effects against *E. coli*.
- Sporulation in *B. subtilis* is a stage where the cell enters a dormant state in order to survive harsh conditions. This dormant state is referred to as the endospore and is a highly resistant form of the bacterium.
- This investigation is to explore the effects of *B. subtilis* on the growth of *E. coli.*

**Methods**

1. **Growth media**
   - **Nutrient broth:** 5 ml of nutrient broth is poured into a test tube. This is done to ensure that the media is ready to use.
   - **Culture media:** 5 ml of culture media is poured into a test tube. This is done to ensure that the culture media is ready to use.

2. **Microorganisms**
   - ***Bacillus subtilis***: 1 ml of *B. subtilis* is pipetted into the nutrient broth. This is done to ensure that the *B. subtilis* is ready to be used.
   - ***Escherichia coli***: 1 ml of *E. coli* is pipetted into the nutrient broth. This is done to ensure that the *E. coli* is ready to be used.

3. **Incubation**
   - The nutrient broth is incubated at 37°C for 24 hours. This is done to ensure that the media is ready to use.

4. **Media setup**
   - **Nutrient broth:** 5 ml of nutrient broth is poured into a test tube. This is done to ensure that the media is ready to use.
   - **Culture media:** 5 ml of culture media is poured into a test tube. This is done to ensure that the culture media is ready to use.

5. **Microorganisms**
   - ***Bacillus subtilis***: 1 ml of *B. subtilis* is pipetted into the nutrient broth. This is done to ensure that the *B. subtilis* is ready to be used.
   - ***Escherichia coli***: 1 ml of *E. coli* is pipetted into the nutrient broth. This is done to ensure that the *E. coli* is ready to be used.

6. **Incubation**
   - The nutrient broth is incubated at 37°C for 24 hours. This is done to ensure that the media is ready to use.

**Results**

- **Figure 1:** This is a gram stain of *B. subtilis*.
- **Figure 2:** This is a gram stain of *E. coli*.
- **Figure 3:** This photo shows the bacterial colonies after 24 hours of incubation.
- **Figure 4:** These photos show there is a clear portion where the bacteria were killed and there is no growth.
- **Figure 5:** This photo shows how the zone of inhibition on each plate was measured.
- **Figure 6:** This photo shows how the zone of inhibition on each plate was measured.
- **Figure 7:** This photo shows a control plate from our trial.
- **Figure 8:** This photo shows the bacterial colonies after 24 hours of incubation.

**Conclusion**

- The statistical significance of the data suggests that the antibiotics that are produced by *B. subtilis* have a statistical effect on the growth of *E. coli*.
- The p-value from the Independent T-test came out to be less than 0.001.
- The results for this investigation calls for the null hypothesis to be rejected and conclude that *B. subtilis* has the ability to produce antibiotics when in competition with *E. coli*.
- The idea that if they were to meet in the presence of the stomach, *B. subtilis* has the ability to kill *E. coli*.
- The main question of this investigation was to see if the antibiotics produced by *B. subtilis* would have an effect on the growth of *E. coli*. This question was answered in the fact that the antibiotics were able to kill *E. coli* for *B. subtilis* to grow.

**Discussion**

- Analysis results conclude that the antibiotics that are produced by *B. subtilis* do have a statistical effect on the growth of *E. coli*.
- The independent t-test proved this hypothesis to be true but why are the results from this investigation so unexpected? The results show that the antibiotics produced by *B. subtilis* do have a significant effect on the growth of *E. coli*.
- *B. subtilis* is unique in that it has the ability to produce antibiotics that can inhibit the growth of *E. coli*.
- These values can be used to conclude the experiment using an Independent T-test.

**References**


**Acknowledgements**

- Laura Johnson (Contract Specialist/Research Microbiologist, USDA) for her help and guidance.
- Mike Suddell (STEM Lead Teacher/PLTW Biomedical Science Teacher) for his guidance.
- All of the Capstone Class for the constructive criticism.
- All of the PLTW mentors also for the constructive criticism.
Title  
**Salicylic Acid vs. Benzoyl Peroxide: Comparing Ability to Eliminate Bacteria and Oil From the Skin**

**Summary**
Many teens today suffer from acne, and the most common solution is using a medicated facial cleanser such as those containing salicylic acid (SA) or benzoyl peroxide (BP).

This capstone project was performed to determine whether SA or BP is more effective at eliminating bacteria and oil from the face. In order to collect data, initial oil and bacteria swabs had to be taken and weighed/plated. The test subjects then used the SA cleanser on the right side of their face while using the BP cleanser on the left side. Following that, oil and bacteria swabs were taken again and weighed/plated.

After analyzing the data, it was determined that both cleansers were effective at eliminating oil, but there wasn’t a significant enough difference between the two in order to declare one as more effective at eliminating oil from the face. It was also determined that while the SA cleanser had a different effect on the amount of bacteria, it was not significant enough to be declared as more effective at eliminating bacteria from the face.
Salicylic Acid vs. Benzoyl Peroxide: Comparing Ability to Eliminate Bacteria and Oil From the Skin

Emma Biddle
PLTW Biomedical Science, Perryville High School

Methods
1. Prepare 12 nutrient agar plates and fill 4 cup collection tubes with distilled water.
2. Swab test subjects right side and left sides of their face separately and weigh the swabs.
3. Swab each side of their face for bacteria and dip the swabs into the distilled water.
4. Allow incubating the distilled water for 24 hours, plate the solution and incubate the plates.
5. After 48 hours observe plates.
6. Have the test subject follow the video and wash face with SA cleanser on right side of their face and then use BP cleanser to wash their left side of face.
7. Repeat steps 2-5.
8. Repeat the entire procedure for each test subject.

Abstract
Many teens today suffer from acne, and the most common solution is using a medicated facial cleanser such as those containing salicylic acid (SA) or benzoyl peroxide (BP). This capstone project was performed to determine whether SA or BP is more effective at eliminating bacteria and oil from the face. In order to collect data, initial oil and bacteria swabs had to be taken and weighed/plate. The test subjects then used the SA cleanser on the right side of their face while using the BP cleanser on the left side. Following that, oil and bacteria swabs were taken again and weighed/plate. After analyzing the data, it was determined that both cleansers were effective at eliminating oil, but there wasn’t a significant enough difference between the two in order to declare one as more effective at eliminating oil from the face. It was also determined that while the SA cleanser had a different effect on the amount of bacteria, it was not significant enough to be declared as more effective at eliminating bacteria from the face.

Introduction
Acne is a skin condition that occurs when your hair follicles become clogged with oil and dead skin cells (1). While salicylic acid naturally exfoliates the skin, preventing pimples (2), benzoyl peroxide kills the bacteria-causing acne and clears clogged pores (3). The sebaceous glands in the skin produce sebum which is an oily, waxy substance that coats, moisturizes, and protects your skin (4). The problem starts when there’s an overproduction of sebum, resulting in oily skin. This oily skin clogs pores along with dirt and leads to acne.

Hypothesis
Alternative hypothesis: The cleanser with benzoyl peroxide will be more effective at eliminating bacteria and oil from the skin.

Benzoyl peroxide is antibacterial therefore it will kill the bacteria much more efficiently. It is also known as the “stronger” ingredient (1), which causes it to dry out the skin more. This would result in less oil on the skin.

Discussion
- According to the results, the null hypothesis was not rejected, being that neither of the cleansers worked significantly better at eliminating oil and bacteria from the skin than the other.
- When comparing the oil differences between cleansers, the p-value was 0.4482/06. When comparing bacteria differences between the cleansers, the p-value was 0.2374/67 (both under 0.05). Although both cleansers were effective at eliminating oil, one did not do a better job than the other.
- Overall, the SA cleanser had an effect on the amount of bacteria, but not statistically more than the BP cleanser.
- Those who are more focused on finding a cleanser effective at eliminating oil could use either of these cleansers.
- If this project were to be repeated, the number of test subjects would need to increase to at least six. The more data there would be to analyze, the more accurate the results would be.

Results
Figure 1: Sample of before and after plates from the SA cleanser
Figure 2: Before plate of BP.

Table 1: Dependent T-test results

<table>
<thead>
<tr>
<th>Test</th>
<th>Before vs. SA BP</th>
<th>Before vs. BP</th>
<th>SA vs. BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of Freedom</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>T-value</td>
<td>0.32</td>
<td>0.83</td>
<td>0.29</td>
</tr>
<tr>
<td>P-value</td>
<td>0.75</td>
<td>0.41</td>
<td>0.77</td>
</tr>
</tbody>
</table>

Table 2: Independent T-test results

<table>
<thead>
<tr>
<th>Test</th>
<th>Before vs. SA BP</th>
<th>SA vs. BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of Freedom</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>T-value</td>
<td>0.32</td>
<td>0.29</td>
</tr>
<tr>
<td>P-value</td>
<td>0.75</td>
<td>0.77</td>
</tr>
</tbody>
</table>

Conclusion
Those looking for a cleanser to get rid of acne-causing bacteria should not turn to either one of these cleansers for help, according to this specific experiment.
Those looking for an effective solution for oily skin could use either of these facial cleansers according to this specific investigation.
Further testing needs to be done in order to come to more accurate conclusion.

References
The Effect of a Mouthguard’s Fit on Bacterial Growth

Summary
This investigation researches what type of mouthguard fit will collect the least amount of bacteria. The four types of mouthguard fits are: retainer style, loose mold, no mold, and braces mold.

Many athletes get sick and experience dental issues such as gum disease and tooth decay from their mouthguards. If mouthguards are not washed regularly and kept in a secure case, they can potentially grow dangerous bacteria that can cause serious health issues.

Using the following procedure, the four popular mouthguards were tested to explore which one would collect the least amount of bacteria: First, the mouthguards were placed on plastic teeth that had E.coli on them. Then they were left to sit on the teeth for an hour. Lastly, the mouthguards were then swabbed and plated.

Based on the colonies growth of each mouthguard, we were able to determine the SISU mouthguard (retainer style) prevented the growth of bacteria. The Wilson mouthguard (no mold) was the least effective in preventing bacteria growth.
The Effect of a Mouthguard’s Fit on Bacterial Growth
Jordan Carr
PLTW Biomedical Science, Perryville High School

Abstract
- This investigation researches what type of mouthguard fit will collect the least amount of bacteria. The four types of mouthguard fits are: trainer style, loose mold, mold, and braces mold.
- Many athletes get sick and experience dental issues such as gum disease and tooth decay from their mouthguards. If mouthguards are not washed regularly and kept in a secure case, they can potentially grow dangerous bacteria that can cause oral infections.
- Using the following procedure, the four popular mouthguards were tested to see which one would collect the least amount of bacteria. First, the mouthguards were placed on plastic teeth that had E.coli on them. Then they were left to sit on the teeth for an hour. Lastly, the mouthguards were then swabbed and plated.
- Based on the colony growth of each mouthguard, we were able to determine the Sisu mouthguard (trainer style) prevented the growth of bacteria. The Wilson mouthguard (no mold) was the least effective in preventing bacterial growth.

Background
Many popular sports in the United States require athletes to wear a mouthguard. Mouthguards are used to protect the teeth from injury and damage. Mouthguards can range from $2 to $150, which makes replacing them hard for some families. Mouthguards do not seem to happen very often, but “the most common sports injuries, and the one with the biggest bill, is damaged teeth” (1). A common issue both professional and recreational athletes share is the bacteria that builds up in mouthguards after several years (2). Bacteria on a mouthguard can lead to a number of possible issues, including tooth decay and gum disease (3). With the build-up of bacteria, many athletes refuse to wear their mouthguard due to the bacterial contamination. The buildup also requires mouthguards to be frequently replaced which can be expensive for families.

This investigation will explore whether the style of a mouthguard impacts the bacterial colonization of the mouthguard. Four different mouthguard styles, each with a different style of fit (Figure 1-4), will be exposed to a solution of Escherichia coli strain ATCC 25922 (E. coli X12). Samples from each mouthguard will be plated to determine the presence of and relative concentration of bacteria. It is hypothesized that mouthguards with a loose fit will collect less bacteria after each wear. This is believed to be the outcome because the loosier the mouthguard fit is against the teeth, the less bacteria that will build up. This investigation is important because athletes are getting sick due to the bacteria in their mouthguards. According to a study published by American General Dentistry (AGD), “most guards can be the breeding ground to life-threatening bacteria, yeast and mold. Germs found in mouthguards can lead to strep and staph infections, which could leave the entire team on the bench” (2).

Hypotheses
- Null Hypothesis: Fit of a mouthguard will have no effect on the bacterial growth
- Alternative Hypothesis: The tighter the fit of a mouthguard the higher the bacteria concentration.

Methods
1. Sterilize the jaw for two minutes and the mouthguard for one in 10% bleach.
2. Once the mouthguards are dry take a dry sterile cotton swab to the inside of the mouthguard and swab across the inside three times, and plate what is collected.
3. Completely submerge the top jaw into the E. coli solution for one minute.
4. Place sanitized mouthguard onto the upper teeth and leave for one hour.
5. After the hour is complete, remove the mouthguard and swab the mouthguard across the inside.
6. Dilute the swab and complete serial dilutions (see figure five) down to 10^-6.
7. Take 5ul from well 5 and plate onto a plate and streak for colonies (see figure six).
8. Place completed plates upside down and label with mouthguard type.
9. Repeat steps one through thirteen for each trial of the mouthguard.
10. After all completed plates into the incubator, leave them at 37°C for 48 hours.
11. After 48 hours record the growth of bacteria on each plate by using a Carolina Dissecting Microscope 581815-count individual colonies.

Figure 5: How to serial dilute

Figure 6: How to streak for colonies

Results

Figure 8: Sisu plate with E. coli colonies

Figure 9: Wilson plate with E. coli colonies

Figure 7: Bar graph of average growth on each plate

Figure 10: SD Braces plate with E. coli colonies

Figure 11: SD Normal plate with E. coli colonies

Discussion
- Although my null hypothesis was rejected because my p-value was .034655, my alternative hypothesis was incorrect. The tighter fit actually had the lowest bacteria concentration, not the highest.
- It can also be determined that the Sisu mouthguard did the best job at preventing bacteria from building up, and the Wilson did the worst.
- Preventing bacteria’s build-up.
- With the Sisu, the “perforations allow for better flow of saliva and prevent bacteria from pooling in the mouthguard” (3), and also prevent foreign bacteria from slipping between the guard and the teeth. This is what gives it a lower bacteria concentration, because it is harder for bacteria to slip between the guard and the teeth.
- Athletes can wear the Sisu mouthguard and have a lower chance of getting sick.

Conclusion
- P-Value: .034655, which means that the fit of the mouthguard does have an effect on the amount of bacteria collected on it.
- Sisu mouthguard held the lowest bacteria concentration, followed by the Black Doctor (braces), then the Black Doctor (normal), and the Wilson mouthguard had the highest bacteria concentration.
- It was determined that the Sisu mouthguard has the lowest bacteria concentration, meaning it is less likely to cause sickness to athletes and does not have to be replaced as often.

Acknowledgements
Mr. Larry Sickel, STEM and Biomedical Science teacher, Perryville High School
Mrs. Nicole McKinn, Human Capital Outreach Specialist
C1 - Human Capital Planning & Development U.S. Army Research, Development & Engineering Command
Mrs. Christine Zelinski, STEM Instructional Coach

References
Title  Toe Protection

Introduction
Our product, The Toe Turtle, is a solution to a common problem in high intensity sports. This problem is toe injuries. We conducted surveys in five different high schools around our area. The results overwhelmingly proved that there is demand for a product that both protects athletes toes, and is comfortable.

Conclusions
The Toe Turtle is an effective product that offers good protection from toe injuries, with ease of use. It filled a need for athletes who want extra protection for their toes. It is cost effective and easy to make. It is also extremely customizable so it can fit all different kinds of cleats. Because of the current circumstances we did not get to actually do the testing.
Toe Protection

Nicholas Romano and Teno Christofano
Honors Engineering Design and Development, Perryville High School

Introduction
Our product, the Toe Turtle, is a solution to a common problem in high-intensity sports. This problem is toe injuries. We conducted surveys in five different high schools around our area. The results overwhelmingly proved that there is demand for a product that both protects athletes toes, and is comfortable.

Materials and methods
The Toe Turtle would have made out of high impact polystyrene. This material provides a high resistance to impacts however it is also cheap to get and can be formed into whatever shape is needed to fit the size of the cleat.

The Toe Turtle would be thermoformed into a shell of high impact polystyrene. This process is easy to do and can be repeated quickly and at a high efficiency. This makes it far superior to 3D printing or casting.

Hypothesized testing and results
Our testing was going to include three different tests, a flexibility test, a hammer drop test, and functionality test.

Flexibility test:
In this test the Toe Turtle would be placed in a device that would bend it to different degrees. We would test its ability to flex but also return to its original shape. We hypothesize that our product would do the worst in this test, as flexibility was kept in mind for its design but impact resistance is its primary goal.

Hammer drop test:
In this test the Toe Turtle would be held in place on the ground. A hammer would then be dropped head down from 1,3,5,6 feet. This would test the impact resistance with different levels of impact. We hypothesize that the Toe Turtle would do very well in this test. Due to the half dome shape of the toe guard section of the Toe Turtle it would have been highly resistant to impacts even with high force.

Functionality test:
In this test an athlete would wear it and perform different kinds of physical movement. A sprint and agility, the results would be gathered from the athletes feedback on how the toe turtle feels and acts. We hypothesized that the test would be successful and the athlete would not notice the toe turtle after the first few minutes with it in their cleat.

Figure 2. This is an example of a thermoforming machine. The sheet of material is heated until it is flexible. Then it is dropped onto a mold of the product. A vacuum is then pulled and the hot material is pulled over the mold and it cools, resulting in an exact replica of the mold.

Prototype design: initial drawings
Our first drawing of the Toe Turtle consisted of the cover that went over only the toe, and having an elastic strap. We decided to remove the elastic strap for the final project. We also decided to remove the bottom of the toe guard.

Conclusions
The Toe Turtle is an effective product that offers good protection from toe injuries, with ease of use. It filled a need for athletes who want extra protection for their toes. It is cost effective and easy to make. It is also extremely customizable so it can fit all different kinds of cleats. Because of the current circumstances we did not get to actually do the testing.

Literature cited
US patent #20190350273
US patent #20190350273
US patent #7367074BI
US patent #20090255147A1

Acknowledgments
Danei Kisel
Michael Lichtner

For further information contact
tenochristofano@gmail.com
nichrome24655@acps.org
Title  Fire Sprinkler and Suppression

Summary
The idea of this product is to get more people to install sprinkler systems within their houses by eliminating some of the common problems that people have with the normal sprinkler systems. For example, the extinguisher lays a blanket of foam on top of the fire which takes away the oxygen and shrinks the fire.

This extinguisher is not only just as effective as water, but it is easier to clean up and causes less amount of damage to the house. With a water sprinkler a lot of people deal with more money in water damage then actual fire damage. This system would also be cheaper and you wouldn’t have to lay pipes all throughout the ceilings of your house. This products would hopefully get people to install some sort of sprinkler system within their houses which would slow the death rates of people in house fires.
Fire Sprinkler and Suppression

Samantha Copenhagen, Brayden Adkins
Honors Engineering Design and Development, Perryville High School

Introduction

The number of fatalities from house fires are on the rise. Many property owners are unaware of the common problems with their traditional sprinkler system or they do not have the money to put the sprinklers in their house. Our goal is to reduce the amount of human contact that is needed to put out a fire. This will allow people to get out of the house faster when they are not worried about trying to put the fire out themselves. Many fire safety companies have collected statistics on house fires. These statistics include how they start, and how many people average the fire in a year in fires. Companies will talk about the flaws of sprinklers like pipes freezing, the amount of water damage that is caused from the sprinkler, in some cases the sprinkler have not worked or worked effectively. We will test our project based on if the fire is reduced in size, and to keep the fire contained. We will use concepts like chemical compounds, math formulas, and controlled systems. We will need to gain access to basic sprinkler heads, and materials to modify new sprinkler heads to work with our designs. For these designs are plan to take ideas from the patented ideas to make them work better and more effectively.

Benmarks to Be Tested on

Does it put out the fire?

Does it slow the growth of the fire?

How fast does it react to the fire?

Testing

We are going to test our sprinkler systems on two major categories. These two categories are that the fire has been reduced in size, and that the fire can be contained to one area and is not spreading. If it was not put out already, we will have a control of the normal sprinkler head or the most commonly used type of sprinkler system that we will test our prototypes against.

For testing, our product would be put through the same testing as a normal sprinkler system. We would compare the two on how it reacts to fire. If it slows the growth of the fire or did it completely put out the fire. Most importantly it would be tested to make sure it works accurately and can be reliable. This is because it is not often that you would have a housefire but in the event that you did you need to know that you have a reliable system that is going to work.

Materials and methods

If we were able to put out the school yard and finish our project the goal was to create a sprinkler that would work directly. This would use a fire extinguisher and a normal sprinkler head. The fire extinguisher would allow for it to be easily changed, and also customize the area or room that this would be installed in.

Marketing

This product would be a more affordable option compared to the normal sprinkler systems. With a normal sprinkler system you have to pay a lot up front in order to get all of the piping installed through the house or building. With this system there would be no pipes just the extinguisher canister hooked up to the sprinkler and which activated would be sprayed on the fire. This product would also be customizable per room it is in. For example you would see a different extinguisher for the kitchen then a bedroom. It would even reduce the amount of water damage done in a house when a small fire occurs.

These images are the standard items that we were planning on using in our design and prototype in order to make our design functional and affordable.

Concepts Used:

Some of the concepts that will be used within our designs are going to be volume formulas, chemical compounds found in the fire extinguisher, and the ways water or the chemicals in the extinguisher will react with specific fires (chemistry), salt, containment, a heat system and control systems. These are all math, science, and engineering that we will have to use and keep in mind throughout our prototyping and testing.

Conclusions

In conclusion, the idea of this product is to get more people to install sprinkler systems within their houses by eliminating some of the common problems that people have with the normal sprinkler systems. For example, the extinguishing agent used in the fire extinguisher is not only as effective as water, but it is easier to clean up and causes less amount of damage to the house. With a water sprinkler, the money people deal with enumeration in water damage than actual fire damage. This extinguisher would be cheaper and people wouldn't have to lay pipes all throughout the ceilings of your house. This products would hopefully get people to install some sort of sprinkler system within their houses which would slow the death rates of people in house fires.

Literature cited


For further information

Email samcopen228@goo99.org or you can reach out to Perryville High School and I will be in contact with you shortly.
Title  The Physiological Effects of Cell Phone Notifications on Teenagers

Summary
The purpose of this investigation was to determine if cell phone notifications caused anxiety in teenagers. Eight teens (juniors and seniors) attending Perryville High School had their heart rate and blood pressure tested before and after hearing an iPhone text tone to simulate getting a notification. It was found that the data supported the alternative hypothesis. Cell phone notifications did cause an anxious response in teens. With a p-value of .00325, the difference between heart rates before and after a notification are significant. This means that the text tone had an effect on the teen’s heart rate. With a p-value of .00562, the differences between systolic blood pressure were significant, and the notification had an effect on a teen’s systolic blood pressure. With a p-value of .00825, the differences between diastolic blood pressure before and after hearing a text tone were significant. Hearing the text tone had an effect on teen’s diastolic blood pressure, causing it to rise. As a result of this investigation, it was found that teen’s do show a physiological response to cell phone notifications.
The Physiological Effects of Cell Phone Notifications on Teenagers
Chloe Clarke
PLTW Biomedical Science, STEM Academy
Perryville High School

Abstract
The purpose of this investigation was to determine if cell phone notifications caused anxiety in teenagers. Eighteen teens (juniors and seniors) attending Perryville High School had their heart rate and blood pressure tested before and after hearing an iPhone text to simulate getting a notification. It was found that the data supported the alternative hypothesis. Cell phone notifications did cause an anxious response in teens.

Methods
1. Gather all materials (Laptop, Venier blood pressure cuff, Venier heart rate monitor).
2. Connect the heart rate monitor and the blood pressure cuff in the computer.
3. Once all technology is properly accounted for, the participant sits down, and is instructed to take hold of the heart rate monitor. At the same time, the blood pressure cuff is wrapped around their arm.
4. Play a “call” on the “Venier” program.
5. Collect the participant’s heart rate for five minutes, and collect the participant’s blood pressure.
6. Click “stop”.
7. Record data.
8. Inform the participant of the need to collect another set of data.
9. Click “collect” once more.
10. After one minute, play the iPhone text message ringtone.
11. Record data.
12. After all data has been collected, brief the participant.
13. Repeat steps for all available participants.

Results

Background
- 90% of teens have smartphones, and 89% of teens send and receive text messages daily. (McClain, 2018). According to the Washington Post, “81 percent (of parents) believe their teenagers are ‘addicted’ to their mobile devices.” (Timberg, 2019).
- Cell phones run on a variable reinforcement schedule. (Firestone, 2017). This type of reinforcement schedule gives the user a random reward at random intervals. This is what makes people keep checking, thus promoting anxiety.
- Dopamine is a chemical neurotransmitter in the brain that gets released when a person expects or receives a reward. (Bruckbauer, 2019). The dopamine that is being received is telling the brain that whatever is happening, it is worth getting more of.
- People under the age of 25 are even more susceptible to becoming dependent upon their phones because their brains are not completely matured until the age of 25 (Amour, 2011).
- The aim of this project is to explore the physiological effects of cell phone notifications on teens.

Hypotheses
- H1: Cell phone notifications will have no effect on teenagers
- H2: Cell phone notifications will cause a teen’s heart rate and blood pressure to elevate, and create an anxious physiological response.

Conclusion
- P-value of heart rate: .00325
- P-value of systolic blood pressure: .00062
- P-value of diastolic blood pressure: .00822
- All p-values are significant (> .05). This means that the cell phone notifications had an effect on the participants’ heart rate and blood pressure.
- Falsify the alternative hypothesis.
- Repeat the hypothesis.
- Cell phone notifications create anxiety in teens.

Discussion
- This research shows that anxiety, stress, depression, and decreased sleep have all been linked to cell phone use. (Shekut, 2019)
- This means that the cell phones do cause an anxious response.
- Potential applications
  - Even though a survey was sent out to all juniors and seniors, and multiple announcements were made, there were only 18 participants who fit the eligibility of the study.
  - The heart rate monitor often would report readings that are not humanly possible. For example, heart rates of over 500 bpm. This limitation made it a little bit more difficult to get consistent readings quickly and with accuracy.
  - Also, it is important to think about the fact that almost all of the testing was done after lunch. This means that the participant’s blood pressure could have been reflecting the food they ate.
  - Being in an unfamiliar room with an unfamiliar person also could have created an anxious response including an elevated heart rate and blood pressure.
- In order to expand upon this investigation, more teenagers will need to be tested. Thus, possibly gender could be factored into the investigation. This could also be expanded to include people of different age groups and ethnicities.

Acknowledgements
Ms. Alyssa Henry, School Psychology Intern for Cecil County Public Schools
Mr. Larry Stichels, STEM and Biomedical Science teacher, Perryville High School

References
Alida Coggins
Grade 12
Perryville High School

Honors PLTW Biomedical Sciences Capstone
Honors STEM Research and Design Capstone
Teacher: Larry Sickels

Title
The Effect of Different Types of NSAIDS on E. coli

Summary
- There is significant evidence to suggest that NSAIDs play a role in inhibiting E.coli growth. The results of the significance test for each drug trial gives evidence that any difference in growth could be by chance alone. In comparison, the results for the control gives evidence that the difference growth was not by chance alone.
- Therefore the results support the alternative hypothesis. Possible reasoning for this can be supported by research that claims NSAIDs may play a role in inhibiting DNA synthesis in some bacteria [3].
- The results showed that the Ibuprofen and Aspirin trials may have seen a small amount of E.coli growth (although not enough to be deemed significant). The reason for this is unknown and more research needs to be conducted.
- Due to the lack of a standard, the values gathered for absorbance cannot be used to determine the actual amount of E.coli seen in each tube. Only relative measurements were gathered in order to test for growth.
The Effect of Different Types of NSAIDs on E. coli
Alida Coggins
PLTW Biomedical Science Capstone
Perryville High School

Background:
- Nonsteroidal anti-inflammatory drugs (NSAIDs) are a class of pain reliever.
- A common side effect of most NSAIDs includes gastrointestinal disorders like abdominal pain, heartburn, constipation and ulcers.
- Escherichia coli (E. coli) bacteria contribute to a healthy microbiome and assist in the breakdown of food [1].

Methods:
- Preparation:
  1. Crush a double dosage (two pills) of each drug. Do this three times.
  2. Prepare 500 mL of nutrient broth.
  3. Create a plate for E. coli stock (check lab notes).
- Growing the Bacteria
  1. Distribute 10 mL of the nutrient broth into 12 test tubes (three tubes per treatment).
  2. Pulling from the stock, swirl E coli into each tube.
  3. Add the crushed drugs to each tube (two pills per tube) but add no drugs to the control.
- Data Collection:
  1. Warm up and calibrate the machine using a blank.
  2. Pipette 2 mL of the “Sus #1” solution into a cuvette and place it in the machine. Click collect. Record the absorbance at a wavelength of 600.
  3. Pour the contents back into the appropriate test tube. Using a clean cuvette and pipette, repeat the process for all other trials.
  4. Place all of the tubes in an incubator set to 37 °C for 48 hours [2]. Repeat steps 7-9.

Results:
A dependent t-test was performed to find any significance between the initial absorbance and absorbance after a 48 hr growth period. The differences were found to be insignificant (p=0.00) for the drug trials while the control was found to be significant with a p-value of 0.2266.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>T-Value</th>
<th>Significant vs Not Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibuprofen</td>
<td>0.2266</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Aspirin</td>
<td>0.049</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Naproxen</td>
<td>0.095</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Control</td>
<td>0.6545</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Conclusion and Discussion:
- There is significant evidence to suggest that NSAIDs play a role in inhibiting E.coli growth. The results of the significance test for each drug trial gives evidence that any difference in growth could be by chance alone. In comparison, the results for the control gives evidence that the difference growth was not by chance alone.
- Therefore, the results support the alternative hypothesis. Possible reasoning for this can be supported by research that claims NSAIDs may play a role in inhibiting DNA synthesis in some bacteria [3].
- The results showed that both Ibuprofen and Aspirin trials may have seen a small amount of E.coli growth (although not enough to be deemed significant). The reason for this is unknown and more research needs to be completed.
- Due to the lack of a standard, the values gathered for absorbance cannot be used to determine the actual amount of E.coli seen in each tube. Only relative measurements were gathered in order to test for growth.

Acknowledgements:
The researcher would like to thank her mentor Mr. Etil Khan for his guidance through the design and execution of the project and the project supervisor Larry Sickles of the Perryville High School Biomedical Sciences Program.

Sources:
Title Creation of an Application for Classroom Communication

Summary
As technology continues to advance and evolve, so should we. The methods of communication in schools are old and inefficient when it comes to the modern generation of learners.

I sought to modernize the methods of communication in a classroom through the creation of an application. This application was designed to allow a teacher to send a mass message to any class of their choice. This allows them to quickly send a message to the recipient through a cell phone and the student to be able to glance at their phone and receive said message.

The creation of the application was done through Android Studio, using JavaScript.
Creation of an Application for Classroom Communication

Tyler Corcoran
STEM Academy, Perryville High School

Abstract
As technology continues to advance and evolve, so should we. The methods of communication in schools are old and inefficient when it comes to the modern generation of learners. I sought to modernize the methods of communication in a classroom through the creation of an application. This application was designed to allow a teacher to send a mass message to any class of their choice. This allows them to quickly send a message to the recipient through a cell phone and the student to be able to glance at their phone and receive said message. The creation of the application was done through Android Studio, using JavaScript.

Introduction
In a poll sent out to CCPs instructors, a large majority all averaged 2 days of communication with their students outside of class. This was taken prior to the school’s release from COVID-19. The same group of teachers showed they would communicate 17.5% more often if a more convenient alternative existed. The application will take place on Android devices with the use of Java. This is due to the numerous resources and conveniences that these provide to quicken the development process and allow for the furthest along prototype possible. This prototype must fulfill all CCPs criteria, or it will prove ineffective to provide a viable method of communication.

Hypothesis

H1: The application created as a result of this project will meet all criteria, including the functionality of the application, the ease of use for the user, and the security of data found on the application.

H2: The created application will not meet required criteria

For the alternative hypothesis to be approved, a survey will be conducted in which users will test Remind, CCPs email, and the prototype application on functionality, ease of use, and convenience. The prototype application will be required to be rated above both Remind and CCPs email.

Methods

Criteria:
- data must be secured and private for all users but accessible when required
- it must be user-friendly
- it must be able to send messages between users in designated groups.

Procedures:
1. Create the UI required for the application in Android Studio.
2. Add function to the UI by creating scripts. This function should work toward the criteria’s completion.
3. Check for any bugs, if any are present, fix the code and recheck for any bugs.
4. Continue repeating steps 1-3 until the application is completed with all desired and required functions.
5. Conduct a survey comparing the created application, Remind, and CCPs Email.

Results

The application was not fully created and did not get far into development. Many UI were created, but little functionality was added to it. Some screenshots of the UI are present to show the application’s current state.

Conclusion

Conclusions that can be met in the aftermath of this project is the process of app development is timely and difficult one. It also requires much time in advance to plan what the application is desired to become. Without all of these factors, the application will certainly fail during development.

Discussion

As it stands in its current form, the prototype is still in the development stages. Due to this, the application would be determined as a failure. The application does not have function, nor does it fulfill CCPs guidelines. The application would need to be given much more time for the application to meet this criteria.

References


Acknowledgments

A special thanks to both John Rodgers, the mentor of this project, to better help me work through issues that occurred during development. A further thanks goes to Larry Sickels, the teacher of the STEM Capstone Course, for helping in the creation of all the documents and the initial idea of the project.
Title  
**The Effects of Dog Saliva on the Growth of E. coli**

Summary

In ancient times, people believed that if they allowed dogs to lick their injuries that it would clean and heal the wound (Burke, A. 2017). Modern research has shown that there is some substance to this claim due to the antimicrobial components present in dog saliva. Dog saliva contains many beneficial properties along with potentially harmful bacteria that would make humans very sick (Slater & Zurz., 2019).

This investigation attempted to confirm the idea that dog saliva can kill bacteria, and to answer the question of whether there is a difference between the antimicrobial properties of male dog saliva and female dog saliva. This was executed by collecting saliva from male dogs and female dogs (n = 3). Soaking susceptibility disks in the saliva, and placing them onto agar plates infused with *E. coli*. The female dog saliva had slightly larger zones than the male dog saliva, but there was not a large enough difference for the data to be proven significant (p = 0.33).

Overall, dog saliva does have some antimicrobial properties that were somewhat effective in killing the bacteria. However, there is not a major antimicrobial difference in the saliva of male dogs versus female dogs.
The Effects of Dog Saliva on the Growth of E. coli
Ashlin Dohler
PLTW Biomedical Science, Perryville High School

Abstract
In ancient times, people believed that if they allowed dogs to eat their injuries that it would cleanse and heal the wound (Burke, A. 2017). Modern research has shown that there is some substance to this claim due to the antimicrobial components present in dog saliva. Dog saliva contains many beneficial properties along with potentially harmful bacteria that would make humans very sick (Stinner & Zure, 2019). This investigation attempted to confirm the idea that dog saliva can kill bacteria, and to answer the question of whether there is a difference between the antimicrobial properties of male dog saliva and female dog saliva. This was executed by collecting saliva from male dogs and female dogs (n = 3). Snapping susceptibility disks in the saliva, and placing them onto agar plates infused with E. coli. The female dog saliva had slightly larger zones than the male dog saliva, but there was not a large enough difference for the data to be present significant (p = 0.33). Overall, dog saliva does have some antimicrobial properties that were somewhat effective in killing the bacteria. However, there is not a major antimicrobial difference in the saliva of male dogs versus female dogs.

Introduction
• In France they have a saying, “langue de chien, langue de medecin” which means “a dog’s tongue is a doctor’s tongue” (Tsung, J. 2010).
• Dog tails were once thought to be medically beneficial to humans.
• For example, back in ancient Egypt, people used dog saliva to heal their wounds because they believed that the saliva of dogs could cure diseases and heal injuries (Burke, A. 2017).
• It was discovered that wounds that were licked had significantly less contamination of bacteria than wounds that were not licked, and the significance test was 95% (Hart RL, Powell KL, 1990).
• Male and female cats were found to be hemostatic against Escherichia coli O157 and Streptococcus canis (S. canis) but only slightly.
• Despite having many beneficial properties, dog saliva still has the potential to contain lactic acid and viruses that can cause disease in humans (Stinner & Zure, 2019), therefore being licked by a dog is not always beneficial.
• Past research has discovered that dog saliva contains multiple chemical substances, including a variety of antimicrobial meta, like lysosomes (Sanguinetti, G. 2018).

Hypothesis
H1: The female dog saliva will kill and prevent the growth of bacteria more effectively than the male dog’s saliva. This is because females lick and take care of their young, so their mouths would be cleaner to prevent their puppies from becoming sick.
H2: The dog saliva samples will not have any significant antimicrobial effect on the growth of the E. coli.

Acknowledgements
The researcher would like to thank her mentor and project supervisor Mr. Larry Sickels for his guidance and feedback throughout the investigation. She would also like to thank her peers and classmates for all of their help and support.

Results

Figure 1: Collected saliva by holding food to the dog’s nose and rewarding them with an oral sponge.

Figure 2: Created and heated the agar/E. coli mixture, and then poured it into sterile glass petri dishes.

Figure 3: The six water/saliva samples were labeled and then placed into the autoclave for ten minutes.

Figure 4: Nine disks were placed in each of the controls and samples after they were autoclaved.

Figure 5: The disks were removed from the samples, and then placed onto the agar/E. coli plates.

Figure 6: The plates were uploaded to Logger Pro. Each disk had three measurements of the diameter.

Figure 7: Plate 1 of the wound were often removed from the inside. Had an average zone of inhibition of 2.9 cm.

Figure 8: Plate 3 of one of the female dogs named Sacle. This was after it was removed from the inside. Had an average of about 1.5 cm.

Discussion
• Past research shows that there are antimicrobial properties in dog saliva. When inside both female and male saliva were bacitracin against Escherichia coli and Streptococcus canis but only slightly (Korzel, N, 1995).
• This matches the data in this investigation due to the fact that the zones of inhibition remained small and area.
• Some of the data for the dog groups had no zone of inhibition. This may have been because the antimicrobials were accidentally destroyed before they were applied to the bacteria, or possibly the dog had low amount of antimicrobials in its saliva.
• The results of this project also have the potential to aid further research on the components of dog saliva, and its potential applications in the medical field.

Conclusion
• The Independent T-test comparing the water to the saliva samples was significant, so the researcher failed to reject the null hypothesis (p = 0.46). The Independent T-Test comparing the male and female saliva data was proved to be insignificant, so the alternative hypothesis was not able to be accepted (p = 0.33). The One Way ANOVA test showed that there was a statistical difference between the controls and the dog groups (p = 0.0001). However, the results still failed to reject the null hypothesis due to the data comparing the water to the dog saliva was proven to be insignificant.

References
Kay Dumont
Grade 12
Perryville High School

Title  Growth of Antibiotic Resistant E. Coli When Given Probiotics

Summary
This experiment will potentially determine if probiotics inhibit the growth of antibiotic-resistant bacteria.

The data collection was cut short due to COVID-19, and many unexpected problems occurred during data collection. However, the potential results that could have come from this experiment could hypothetically be beneficial in the future because if the E. Coli growth was inhibited, that means that probiotics could be used as a treatment method for illness that are not extreme enough to prescribe antibiotics.
Growth of Antibiotic Resistant *E. Coli* When Given Probiotics

Kay Dumont

PLTW Biomedical Science, Perryville High School

**Abstract**

This experiment will potentially determine if probiotics inhibit the growth of antibiotic-resistant bacteria. The data collection was cut short due to COVID-19, and many unexpected problems occurred during data collection. However, the potential results that could have come from this experiment could hypothetically be beneficial in the future because if the *E. Coli* growth was inhibited, that means that probiotics could be used as a treatment method for illness that are not extreme enough to prescribe antibiotics.

**Introduction**

- *Escherichia coli* (*E. coli*) and a probiotic called *Bifidobacterium Longum* are two commonly found bacterium found in the body.
- Probiotics are a type of "good" bacteria that supposedly boost the health of your digestive system (McMaster, 2017).
- Scientists theorize that probiotics might supplement the loss of other bacteria needed for your health while using antibiotics. Although this is a strong theory, scientists do not actually have an exact reason for how probiotics work.
- In this study, ampicillin-resistant *E. coli* will be given *Bifidobacterium Longum* and their reaction will be observed.

**Hypotheses**

Null: The probiotic will have no effect on the *E. coli*, due to the fact that both bacteria naturally coexist in the body.
Alternative: the probiotics will inhibit the growth of the *E. coli*.

**Methods**

- Add agar to broth, and plate each with 18 ml of agar. Add discs when solid.
- Autoclave 10 minutes.
- Make resistant *E. Coli* broth with the same technique as agar.
- Set up of plates.
- Soak probiotics in water.

**Results**

Due to unexpected problems and an early cutoff, I did not gather any substantial data. However, the “practice test” that was performed before the experiment showed that the results leaned towards the probiotics and *E. Coli* being able to inhibit the dish together, rather than one of them inhibiting the other. The probiotics did not inhibit the *E. Coli*.

**Discussion**

Overall, this experiment got cut short, and no results were gathered. The potential data could have branched off in multiple directions. If this experiment were to be performed again, it would be started earlier, with more in-depth preliminary testing. Considering the control groups, the probiotics most likely would have grown with the *E. coli*, rather than inhibiting it.

**References**

- *Bifidobacterium longum* 25 mg. (n.d.). Retrieved from https://dsusupernmart.com/article?rid=0507#.GQgflA&gclid=EAIaIQobChMlx4w_78d eE5gVUdyGChGGrwTlEAYQYBSABEgkpVP_D_BwE.

**Acknowledgements**

I would like to thank Mr. Sickets for providing materials, and Steven Smith for being my mentor.
Title  The Effect of Temperature on the Transformation of Escherichia coli

Summary
This project was performed to see if temperature truly affects the process of bacterial transformation, specifically focusing on Escherichia coli (E. coli). E. coli is a type of bacteria that is generally used in the scientific world due to it’s shocking factors including rapid growth. This bacteria, along with others, go through a process called transformation, which is when a sudden increase in temperature turns their cell wall porous allowing them to take in foreign DNA and express it. This allows scientists to prove theories and create several medical interventions. In this experiment, E. coli cells were made competent and shocked at 3 different temperatures, hot, warm, and cold. GFP (green fluorescent protein) was used as the foreign DNA, if it was taken in, the colony of bacteria would glow. It was hypothesized that the warmer the temperature, the more efficient the transformation would be, but this was proved wrong by the data.

The data showed that an average of 0 colonies grew for 3 trials for both the hot and warm temperature, followed by an average of 1.66 colonies for the coldest temperature. No scientific research has ever accepted this outcome, nor ever seen it. The data might have been affected by the way the bacteria was shocked, or maybe it was destined to happen. Overall, the whole purpose of this project was to better medical research and hopefully help researchers find the optimum temperature shock for E. coli. This way, more medical advancement can be created, helping the future overcome sickness.
The Effect of Temperature on the Transformation of *Escherichia coli*

Mariana Ercole

PLTW Biomedical Science, Perryville High School

Abstract

This project was performed to see if temperature truly affects the process of bacterial transformation, specifically focusing on *Escherichia coli* (E.coli). E.coli is a type of bacteria that is generally used in the scientific world due to its shocking factors including rapid growth. This bacteria, along with others, go through a process called transformation, which is when a sudden increase in temperature turns their cell wall weaker, allowing them to take in DNA and express it. This allows scientists to prove theories and create several medical interventions. In this experiment, E.coli cells were made competent and shocked at 3 different temperatures, hot, warm, and cold. GFP (Green fluorescent protein) was used as the foreign DNA, if it was taken in, the colony of bacteria would glow. It was hypothesized that the warmer the temperature the more efficient the transformation would be, but this was proved wrong by the data. The data showed that an average of 0 colonies grew for 3 trials for both the hot and warm temperature, followed by an average of 10 colonies for the coolest temperature. No scientific research has ever accepted this outcome, nor even seen it. The data might have been wrong the way the bacteria was shocked, or maybe it was destined to happen. Overall, the whole purpose of this project was to better medical research and hopefully help researchers find the optimum temperature shock for E.coli. This way, more medical advancement can be created, helping the future overcome sickness.

Background

- *Escherichia coli* (E.coli) is a species of bacteria that is widely used in the scientific world for many different purposes such as modelling organisms, testing protein functions, or even for its transformational process.
- Transformation is a process in which, “horizontal gene transfer by which some bacteria take up foreign genetic material (naked DNA) from the environment” (Milpore Sigma).
- One could artificially make competent cells (which are needed for transformation) by using a series of chemicals, or temperate on electrical shocks. An unanticipated increase in temperature, creates pores in the cells membrane, allowing for DNA to insert itself (Jones). Once the DNA is inserted, the bacterial cell will be able to express it.
- GFP (Green Fluorescent Protein) is often spilled into tissues to be incorporated into bacteria during transformation investigations. Their ability to glow enables researchers to "see when proteins are made, and where they go" (Concell Education, 2016).

Hypotheses

- Alternative Hypothesis: The warmer the temperature, the more efficient the transformation will be.
- Null Hypothesis: The colder the temperature, the more efficient the transformation will be.

Methods

1. Create 5 LB agar plates/mm and 5 LB Amp IPTG agar plates (25mm)
2. Plate the E.coli on a LB agar plate and inoculate for at least 24 hours
3. Create competent cells by soaking the E.coli (the one that was grown) with one of the bacterial transformation buffers in the tubes provided by the kit and flick it to mix
4. Then add the GFP plasmid with a pipette and flick once again
5. Incubate the mixture in the fridge for 30 minutes
6. Shock the mix according to the controlled temperature being tested (70°C, 42°C, and 14°C) for 30 seconds in a dry bath
7. While the mix is being shocked, fill a LB agar microcentrifuge tube mostly full with room temperature water and shake, pipette half of the mixture into the tube containing the now shocked samples
8. Incubate this in the incubator (37°C) for 2 hours
9. Add 4-6 drops of the mix onto the LB Amp plate and spread evenly with a sterile spreader onto 3 different LB Amp IPTG plates, and label
10. Incubate at 37°C for 24 hours
11. Put agar plates on the BlueView Transilluminator and observe the amount of growth and how many colonies glow
12. Repeat steps 3-10 until all controlled temperature shocks are completed

Results

- Temperature: 14°C, plate number 3 had the highest number of colonies.
- The p-value was 1101, which means we fail to reject the null hypothesis, which states that the colder the temperature, the more efficient the transformation will be.

Discussion

- The results of the experiment have shown that the coldest temperature that was tested had the most efficient bacterial transformation process. According to addgene, the optimal temperature for bacterial transformation is 42°C, therefore, last number 2 should have been the most efficient.
- This could have occurred because the temperature shocks could have brought too close to the desired temperature fast enough to make the cells active.
- The results were not significant as the p-value assessed was below 5. This means that the null hypothesis, the colder the temperature the less efficient the transformation will be, was false to be rejected.
- This experiment can allow one to understand if a specific temperature is best suited for the transformation efficiency of E.Coli cells, enhancing medical research, benefiting the community.

Conclusion

- The most efficient temperature that was tested is 14°C. Plate number 3 was the only plate out of all temperature that had glowing colonies on it.

References


Acknowledgements

Dr. Oudaymac Omar Dailo, Senior research scientist, Botallone
Mr. Larry Sicken, STEM and Biomedical Science teacher, Perryville High School
Title  Innovative and Re-imaging Utensils for Efficient Handwriting

Introduction
81% of all people claim to have bad handwriting. All around the world, in any school setting, the people attending them often struggle with horrific handwriting. Our idea was to create a utensil, aiding children through young adults as they enhance their handwriting to become more efficient and an overall neater projection of their writing.

Further Plans/Conclusion
At this point, we were halted in finishing our project due to COVID-19. We were in the process of beginning to 3D print while finding the correct material as far as foam. Our extended plans included developing a rough and finalized product, made entirely out of 3D material and authentic foam until we were satisfied with the outcome.
Innovative and Re-imaging Utensils for Efficient Handwriting

Alexander Reynolds and Eddie Hanssen
Honors Engineering Design and Development, Perryville High School

Introduction
81% of all people claim to have bad handwriting. All around the world, in any school setting, the people attending them often struggle with horrific handwriting. Our idea was to create a utensil, aiding children through young adults as they enhance their handwriting to become more efficient and an overall neater projection of their writing.

Figure 1. The first organization our group discovered to lead us on the correct path with our project: International Graphology Society

Initial Destination
Our projected idea at the beginning of this assignment was to create a free air writing pen, used in a form of a projector, possibly a smartboard which are located in most classrooms. This pen would allow the user to write in the air with the device, projecting the print with automatic alteration of the writing through coding to allow the user to improve their handwriting.

Figure 2. This image was discovered during our patent research project, which incorporated an axis which would be essential for the product we were attempting to create.

Prior Info and Past Solutions
In this stage, we researched past attempts at a similar product idea. We researched patent ideas for guidance and information surrounding our initial idea. Our group found several similar ideas with in-depth detail. However, these products were very expensive and highly intricate, in which we were forced to change paths of our product idea.

Figure 3. The image above is also from our patent research assignment, in which the pressure of the user reflects the efficiency of the outcome.

Project Idea
As it came down to the production of our actual product we decided to create a foam pencil. This idea acts as a fully functional utensil with the outer shell remaining as foam, which molds to the user’s fingers in recall of efficient handwriting and the overall improvement of the individuals print.

Figure 4. Above resides our first written projected prototype as we thoroughly plan out the design of our product. Shown above is a standard 0.9mm BIC mechanical pencil wrapped in foam.

Prototyping
During our prototyping, we planned on 3D printing the base utensil and were unsure of the type of foam to use for our final product. When creating our actual prototype, we wrapped a standard BIC mechanical pencil in foam found on school property that closely resembles the ideal foam for our final product.

Figure 5. Our prototyped foam pencil

Further Plans/Conclusion
At this point, we were halted in finishing our project due to COVID-19. We were in the process of beginning to 3D print while finding the correct material as far as foam. Our extended plans included developing a rough and finalized product, made entirely out of 3D material and authentic foam until we were satisfied with the outcome.

Figure 6. Above is the dimensions of the standard BIC mechanical pencil that was destined to be recreated through 3D print.

Literature Cited

Acknowledgments
We thank Daniel Keck for his support throughout this pandemic and overall throughout our school career within our engineering class.
Title  White Tea Leaf Aqueous Extraction Using Centrifugation Against Escherichia coli, and Bacillus cereus

Summary
Plants are known for their healing properties, especially tea. Tea dates back centuries as a remedy to ailments, so the purpose of this experiment was to renew the idea that tea could have healing properties, specifically to the ever growing issue of bacterial infections. In the last few years, antibiotics have proven that their overuse since their discovery has reduced their effectiveness against bacterial infections, creating a dire need for new alternative treatments. This experiment successfully extracted the compounds and molecules from the tea that gives tea its antimicrobial and healing properties, and grew bacteria against it. The end result showed that the tea extract was effective in inhibiting the growth of e. Coli but not b. Cereus.
White Tea Leaf Aqueous Extraction Using Centrifugation Against *Escherichia coli*, and *Bacillus cereus*

Madison Harrah
PLTW Biomedical Science, Perryville High School

**Abstract**

Plants are known for their healing properties, especially tea. Tea dates back centuries as a remedy to ailments, so the purpose of this experiment was to renew the idea that tea could have healing properties, specifically to the ever growing threat of bacterial infections. In the last few years, antibiotics have proven that their overuse since their discovery has reduced their effectiveness against bacterial infections, creating a dire need for new alternative treatments. This experiment successfully extracted the compounds and molecules from the tea that gives tea its antimicrobial and healing properties, and grew bacteria against it. The end result showed that the tea was effective in inhibiting the growth of *E. coli* but not *B. cereus*.

**Introduction**

- Over the course of the past century of decades, a plethora of antibiotics have been produced to treat a variety of bacterial infections. However, many bacteria have evolved to survive by a biological phenomena making them resistant to antibiotics creating a demand for new medical interventions to protect against or treat bacterial infections (Davis 2010).
- Due to hot tea’s high antimicrobial properties that naturally boost the immune system, reduce the risk of cancer, cardiovascular disease and more, it makes for a common home remedy to numerous ailments (Khan, 2013).
- “Puer Tea” is a term used to describe a less fermented tea, such as white tea as used in this experiment. This gives it an amazing health advantage, because higher antimicrobial compounds are present, called ‘polyphenols’ (Hyungmin, 2017).
- The purpose of the experiment was to identify the effectiveness of white tea’s antimicrobial properties, and to determine if white tea can be used as an antibiotic substitute to treat bacterial infections from *Bacillus cereus* and *Escherichia coli*.

**Hypotheses**

- H1: White tea will show no effectiveness against either *Escherichia coli* or *Bacillus cereus*.
- H2: White tea leaves will be nearly or as effective as against *Escherichia coli* and *Bacillus cereus*, in comparison to the antibiotics.

**Procedure**

1. Measure out nutrient broth into an erlenmeyer flask with 200mL of water. Microscope as needed and autoclave, then let cool.
2. Separate 100mL into another erlenmeyer flask. Use an inoculating loop to stir a healthy amount of *E. coli* from the premade culture, and swirl it in one broth flask. Do the same to the other flask of broth with the premade culture of *B. cereus*.

**Results**

- The only plates with tea extract that had comparable zone of inhibition compared to their antibiotic was *E. coli*.
- *B. cereus* plates show no reaction to the tea extract discs
- *Chloramben* was a more effective antibiotic than *AmpliCin*.
- *t*-value (*E. coli* tea extract versus *E. coli* AmpliCin) = -8.77362
- *t*-value (*B. cereus* tea extract versus *B. cereus* Chloramben) = 48.8837

**Discussion**

- The *t*-value was used to identify if the results were significant, as a replacement for the lack of a negative control group. This *t*-value, as previously mentioned, identifies if the groups are similar as a smaller number, or contrasting, a large number (Tont, Jr.). Because the *Bacillus cereus* plates treated with tea extract has hardly any *z.o.i*, while their counterpart for comparison, Chloramben, had the largest *z.o.i.* of the experiment, it was assumed the *t*-value would be large.
- The alternative hypothesis was proven correct, however, in the *E. coli* plates where the *t*-value proved the tea extract plates were effective enough to be compared to their counterpart, *AmpliCin*.
- Because of this, white tea can be concluded as an effective means to treating *E. coli* infections, but *B. cereus* infections.
- All comparison tests returned a *p*-value of <.00001, proving the data is not due to chance, and could be repeated.

**References**


**Acknowledgements**

Special thanks to Larry Sidwell, Perryville High School’s PLTW Biomedical Sciences Director and Lauren Johnsby, for her mentorship.
Title 3D Printing Lower Limb Prostheses

Summary
The world of medical technology and 3D printing are gradually making their way to become the next best thing in the medical world. 3D printing is a rather new concept, but the medical field knew there could be a great concept. For this project specifically, it was being questioned if a prosthesis could be 3D printed allowing it to be durable and waterproof.

To theoretically test the durability the vertical height was measured, and then different sets of weight plates were added (up to 90lbs) to the top of the prosthesis while it was standing in a locked position.

Although no actual results were found it was noted that finding a waterproof and durable filament was very difficult to find. It was also discovered that designing what will be printed required a lot of practice and time.
3D Printing Lower Limb Prostheses
Cora Hickling
PLTW Biomedical Science
Perryville High School

Abstract
The world of medical technology and 3D printing are gradually making their way to become the next best thing in the medical world. For example, prostheses are starting to become 3D printed more regularly to allow light-weight upper and occasionally lower limb prostheses. While prostheses have been around for many years, 3D printing is rather new concept, but the medical field knew there could be a great concept by combining both ideas. For this project specifically, it was being questioned if a prosthesis could be 3D printed allowing it to be durable and waterproof. To theoretically test the durability the vertical height was measured, and then different sets of weight plates were added (up to 90lbs) to the top of the prosthesis while it was standing in a locked position. To theoretically test if the prosthesis is waterproof the starting weight of each prosthesis will be recorded. Each prosthesis will be left in water for one hour, immediately after the prosthesis is taken out of the water, record the weight, then after 15 minutes, then 30, 45, and finally 60 minutes. If there is any extra weight added at the end of the hour, it shows that the prosthesis is not completely waterproof. Although no actual results were found it was noted that finding a waterproof and durable filament was very difficult to find. It was also discovered that designing what will be printed required a lot of practice and time.

Introduction
In the United States, there are over two million amputees.
- Out of those two million, 840,000 use prostheses.
- 40 - 95% of lower limb amputees use some form of prostheses.
- There are two types of lower limb amputations: transfemoral and transtibial.
- Transfemoral is above the knee amputation (Figure 1).
- Transtibial is below the knee amputation (Figure 2).
- Most typical prostheses are made of either aluminum or titanium.
- 3D printing in the medical community is becoming relatively popular.
- This project seeks to 3D print a proximal and distal pylon that is durable and waterproof.
- The filaments being used to 3D print are Polyactic acid (PLA), Carbon Fiber, and Polylactide terephthalate glycol (PETG).

Hypothesis
Null - None of the 3D printed prostheses will be structurally sound or waterproof.
Alternative – The 3D printed PLA prosthesis will be the most cost effective and it will be structurally sound, and waterproof compared to the typical prosthesis and the other 3D printed prostheses.

Methods
1. Begin to dissect the typical knee joint. After it is decided on the structure and connection points design the proximal and distal pylons and the bevel section (Figure 3). Download as a STL file then slice and print using each filament (PLA, Carbon Fiber, and PETG).
2. Assemble the 3D printed parts with the mechanical knee joint using one filament at a time.
3. Before starting the water tests, spray each knee joint with NeverWet (a waterproofing spray). Take the initial weight of the prosthesis. Submerge the prosthesis in water for one hour. After that hour has passed remove it and record the weight without drying it off. Record the weight after fifty, thirty, forty-five, and then sixty minutes. Repeat this step with each of the filaments and with the typical knee joint.
4. Record the vertical height of each prosthesis. Then using the specifically designed structure to hold the prosthesis in the vertical position (Figure 4), assemble the first 3D printed prosthesis within the structure. After it is secure add a 25lbs weight plate and leave it on the knee joint for thirty minutes. After the 30 minutes is up remove the weight and then record the vertical height. Repeat this same process, but with 35lbs, 45lbs, and then 90lbs. Then repeat this process with the other 3D printed prostheses and the typical knee joint.
5. Compare the data using a Two-Way ANOVA.

Results
Although no actual results were given here is what the theoretical proximal and distal pylons would have looked like:

Figure 5: The design created on Tinkercad of the Proximal Pylon.

Figure 6: The design created on Tinkercad of the Distal Pylon.

Conclusion
- Filament that is waterproof and structurally sound is difficult to find and if it is available it is very expensive.
- Making the filament waterproof was possible by spraying it with NeverWet.

Discussion
- Since there were no actual results it can be determined that the alternative hypothesis was rejected.
- The alternative hypothesis was rejected because the 3D printed prostheses were not structurally sound or waterproof.
- The null hypothesis was accepted.
- Applications for this project include the ability to produce prostheses that are lightweight and waterproof for children to use.

References

Acknowledgements
- Mrs. Mary Reedy, Certified Prosthetist, Darnaymeyer Inc.
- Mr. Larry Sickels, STEM and PLTW Biomedical Science Teacher, Perryville High School
- Mr. Scott Dellosso, English Teacher, Perryville High School
- Mr. James Lewis, student, Perryville High School
The Effect Contact Cleansing Solution on Escherichia coli Growth

Summary
This investigation tested the relative effectiveness of two common contact cleansing solutions, Biotrue and Clear Care Triple Action (CCTA), on eliminating bacteria from contact lenses. A stock solution of Escherichia coli and nutrient broth was prepared and separated into ten beakers. Half of the beakers received 10 ml of Biotrue and half received 10 ml of CCTA. Each beaker was swabbed and plated on a nutrient agar plate before and would have been after treatment. Photos of the plates and what would have been their growth was taken. The photos would have been put through a photo analysis software program to determine if there was less bacterial growth after the solutions were added to the beakers. In light of the COVID-19 pandemic the investigation is inconclusive and further investigation would need to take place to determine if the null hypothesis was rejected or failed to be rejected.
The Effect Contact Cleansing Solution on *Escherichia coli* Growth

Grace Hutchinson
PLTW Biomedical Science Program
Perryville High School

Abstract:
This investigation tested the relative effectiveness of two common contact cleansing solutions, Biotrace and Clear Care Triple Action (CCTA), on eliminating *Escherichia coli* from contact lenses. A stock solution of *Escherichia coli* and antibiotic broth was prepared and separated into ten beakers. Half of the beakers received 10 ml of Biotrace and half received 10 ml of CCTA. Each beaker was swirled and placed on a nutrient agar plate before and after treatment. Photos of the plates and what would have been their growth had they been taken. The photos would have been put through a photo analysis software program to determine if there was less bacterial growth after the solutions were added to the beakers. In light of the COVID-19 pandemic the investigation is inconclusive and further investigation would need to take place to determine if the null hypothesis was rejected or failed to be rejected.

Methods:

- **Treatments:**
  - Biotrace
  - Clear Care Triple Action

- **Bacterial Solution:**
  - *Escherichia coli* stock solution

- **Antibiotic Broth:**
  - Contact lens cleaning broth

- **Growth Medium:**
  - Nutrient agar plates

- **Treatment:**
  - Adding solutions to beakers

- **Analysis:**
  - Photographic analysis of bacterial growth

Discussion:
- Theoretical data that would have been collected from the procedures would have rejected or would have failed to reject the null hypothesis; there would be or there would be no significant difference between the two solutions on their effectiveness on bacterial growth.
- The p-value of the statistical analysis would have been less than 0.05 that the null hypothesis would have been rejected and the alternative hypothesis would have been favored.
- This would have been proven by statistical analysis of the agar plates after they had been analyzed with the photo analysis software. Essentially the solution that had been treated with the CCTA would have had a significantly less amount of bacteria and there would have been less bacterial growth on the agar plates than the control group.
- If the photo analysis software would have determined the growth of each solution’s agar plates to be similar, then the statistical analysis would have proven the data to be not significantly different, (> .05), failing to reject the null hypothesis. This would mean the growth of each solution’s agar plates wouldn’t have been significantly different and each solution hypothetically wouldn’t have a difference on bacterial growth compared to one another.

Conclusion:
- The overall purpose of this project is to compare the effects of two different contact cleansing solutions.
- Multipurpose solutions and hydrogen peroxide are both commonly used and depend on products by consumers.
- Information is important to know as it can educate the population on bacteria on contact lenses and ensure the products are actually killing off the bacteria.

Acknowledgements:
I would like to thank Mr. Sickers for always being a resource of support and encouragement and teaching me the knowledge to get through this project over the past four years. I would also like to thank my amazing mentor, Mrs. Lauren Johnsky who contributed her time, knowledge and experience, and time throughout this entire process.

References:
Title  Development of A Lightweight Myoelectric Prosthetic

Summary
Prosthetic technologies are of an extreme importance in America due to the high rate of amputations occurring daily (300-500). This means that prosthetic technologies need to be more available and useful than ever before, and the plan is to develop a myoelectric prosthetic that does exactly this.

A myoelectric prosthetic is a prosthetic that is powered by a battery and uses the electrical impulses from an amputee’s residual limb to result in the movement of a prosthetic body part. In this case, a trans radial prosthetic was planned on being developed using simple circuitry and 3d printing. Issues arose during the 3d printing aspect of this project, when the 3d printer (a prusa i3 mk2s) failed to complete any print for 3 days and ultimately failed so terribly a replacement hotend had to be ordered. Once this was installed, issues with the bed calibration probe arose and resulted in being unable to print for the rest of the duration of this project.

Had these issues not occurred, The prosthetic would have been assembled and tested using a hand grip dynamometer to gather a general force output, and a weight tolerance test to the strength of the body of the prosthetic and verify the project as a viable option for use in everyday life.
Development of A Lightweight Myoelectric Prosthetic
James Lewis
Perryville High School, STEM Academy

Abstract
Prosthetic technologies are of an extreme importance in America due to the high rate of amputations occurring daily (300-500). This means that prosthetic technologies need to be more available and useful than ever before, and the plan is to develop a myoelectric prosthetic that does exactly this. A myoelectric prosthetic is a prosthetic that is powered by a battery and uses the electrical impulses from an amputee’s residual limb to result in the movement of a prosthetic body part. In this case, a transradial prosthetic was planned on being developed using simple circuitry and 3D printing. Issues arose during the 3D printing aspect of this project, when the 3d printer (a prusa i3 mk2s) failed to complete any print for 3 days and ultimately failed so terribly a replacement hotend had to be ordered. Once this was installed, issues with the bed calibration probe arose and resulted in being unable to print for the rest of the duration of this project. Had these issues not occurred, the prosthetic would have been assembled and tested using a hand grip dynamometer to gather a general force output, and a weight tolerance test to the strength of the body of the prosthetic and verify the project as a viable option for use in everyday life.

Introduction
- There are 3 types of prosthetics, passive, body-powered, and myoelectric
  - This project focuses on myoelectric prosthetics
- Myoelectric Prosthetics often weigh more than their passive and body-powered counterparts, causing muscle fatigue and discomfort throughout the day (Reedy, 2019).
  - This Capstone project attempted to develop a myoelectric prosthesis with a force output and weight tolerance comparable to that of a human hand while placing an emphasis on a lightweight design.
  - The prosthetic design used the right hand from InMoov and a forearm based off of a true myoelectric forearm provided by Mrs. Reedy
  - A simple circuit with a potentiometer was used to simulate muscle contraction.
- This project developed skills in coding, the engineering design process, and expands on an impactful technology. The researcher chose this project because they wanted to explore an interest in coding and recognized the potential of this project to develop said skills.

Hypotheses
- $H_0$: The prosthetic developed will not have a force output or weight tolerance comparable to that of a human hand with an 80% accuracy.
- $H_1$: The prosthetic developed will have a force output or weight tolerance comparable to that of a human hand with an 80% accuracy.

This alternative hypothesis is valid because the motor being used in this project is a high torque motor that will be able to generate a force large enough to complete everyday tasks and be on a similar level to the human hand.

Methods
- **Success criteria**: Force output and Weight tolerance with an 80% accuracy to that of a human hand, weight between 1 and 2 pounds, and a cost less than $200
- **Constraints**: <$200, < 1.5 lbs, developed using additive manufacturing, basic circuitry and home coding.

Independent Variables: Method of production and materials
Dependent Variables: Force output and Weight tolerance

Challenges
- Integration of EMG
  - This project faced difficulties with the EMG due to noise and signal spikes which could not be resolved, resulting in the end product using a potentiometer
- Repeated print failures
  - A part failed for 3 days straight resulting in massive setbacks and the failure of one of the parts of the 3d printer
- Hotend replacement
  - The hotend to the 3d printer had to be replaced, causing another several day delay

Procedure
- Figure 2. Develop a design on paper for the prosthesis
- Figure 3. Begin coding and development of the electrical components
- Figure 4. Transfer prosthetic design to Fusion 360 (the CAD software used in this project) and begin development.

Discussion
- The null hypothesis is favored with no prosthesis being tested to create a force output.
- If this project had been successful, it may have helped develop a more lightweight yet effective myoelectric prosthetic, making the technology much more bearable and effective for those who necessitate the development of this technology.
- This Capstone project will benefit the researcher by developing their ability to use and understanding of coding and how to develop a positively impactful technology.

References

Conclusion
- **Allocate more time to the 3d printing process**
  - The unexpected problems used all of the remaining time for this project
- **Ensure each part works**
  - This occurred with the coding in forms of preliminary tests and would have reduced the chance of failure in the 3d printing process
Title  What Is the Effect of Soil Microorganisms on the Growth Rate of Tiny Tim Tomato Plants *Lycopersicon esculentum*?

Summary
Fertilizers are used to promote growth in plants. The most common fertilizers that are used are chemical. Chemical fertilizers are synthetic and can have harmful effects on the environment, such as adding pollutants into soil and waterways (More, 2019). There are lesser-used microbial fertilizers that do not have detrimental effects on the environment. Microbial fertilizers contain microorganisms that promote plant growth by providing plants with essential nutrients (Science Direct, 2013). This project tested multiple microbial fertilizers on the growth rate of tomato plants against a widely-used chemical fertilizer in order to investigate whether microbial fertilizers could be used in place of harmful chemical fertilizers. To do this, percent change in height over time was measured in each plant, as well as the plant’s wet and dry masses.

The results showed that the chemical fertilizer had the greatest percent change in height over time and the microbial fertilizer with the least variety of microorganisms had the second highest percent change in height over time. There was no statistically significant result concerning which fertilizer had the greatest effect on the wet and dry masses of the tomato plants. It can be concluded that microbial fertilizers have an effect on the percent change in height over time of tomato plants, but chemical fertilizers have a greater effect.
Abstract

Fertilizers are used to promote growth in plants. The most common fertilizers that are used are chemical. Chemical fertilizers are synthetic and can have harmful effects on the environment, such as adding pollutants into soil and waterways (More, 2019). There are lesser-used microbial fertilizers that do not have detrimental effects on the environment. Microbial fertilizers contain microorganisms that promote plant growth by providing plants with essential nutrients (Science Direct, 2013). This project tested multiple microbial fertilizers on the growth rate of tomato plants against a widely-used chemical fertilizer in order to investigate whether microbial fertilizers could be used in place of harmful chemical fertilizers. To do this, percent change in height over time was measured in each plant, as well as the plant’s wet and dry masses. The results showed that the chemical fertilizer had the greatest percent change in height over time and the microbial fertilizer with the least variety of microorganisms had the second highest percent change in height over time. There was no statistically significant result concerning which fertilizer had the greatest effect on the wet and dry masses of the tomato plants. It can be concluded that microbial fertilizers have an effect on the percent change in height over time of tomato plants, but chemical fertilizers have a greater effect.

Introduction

- While the human race has been using organic fertilizers filled with microorganisms for centuries, chemical fertilizers began being used in the early 1900s.
- Chemical fertilizers were used because they worked faster, but they caused water pollution, the destruction of soil microorganisms, and soil infertility (More, 2019).
- Organic microbial fertilizers increase the fertility of the soil through the introduction of healthy microorganisms.
- Microorganisms enhance the growth rate of plants because they are responsible for promoting plant growth hormones and protecting against parasites and bacteria that are harmful to the plants (Food and Agriculture Organization of the United Nations, n.d.).
- The microorganisms are often used in both microbial and chemical fertilizers, which are sold commercially.
- Common types of microorganisms that are found in commercially available microbial fertilizers are rhizobacteria, endomyces and trichoderma fung.
- This investigation seeks to explore the effects of microbial fertilizers on the growth rate of Lycopersicon esculentum ‘Tiny Tim’, otherwise known as Tiny Tim cherry tomato plants.
- Findings from this research could support the use of alternative fertilizers (such as those that incorporate microorganisms), over the use of harmful chemical fertilizers.

Hypothesis

Alternative: A microbial fertilizer that contains a greater variety of microorganisms and claims to promote plant growth will result in a higher growth rate of tomato plants than a mixture that contains a lesser variety of microorganisms.

Null: The microbial fertilizers will have no effect on plant growth.

Methods

- Figure 1: Germinate tomato seeds in sterile soil.
- Figure 2: Transplant seedlings and apply microbial solution.
- Figure 3: Measure the final height of the tomato plants after three weeks.
- Figure 4: Measure the final wet mass of the tomato plants.
- Figure 5: Measure the final dry mass of the tomato plants.

Results

- Average Percent Change in Height Over Time
- Average Final Mass

Discussion

- The alternative hypothesis was proven incorrect. The opposite trend was observed, meaning that a microbial fertilizer that contained a small variety of microorganisms resulted in a higher growth rate of tomato plants than a mixture that contained a large variety of microorganisms.
- The null hypothesis in terms of percent change in height over time was rejected (p=0.023028).
- The null hypothesis in terms of wet mass failed to be rejected (p=0.27862).
- The null hypothesis in terms of dry mass failed to be rejected (p=0.106347).
- These results could have been affected by the limited growing period of the tomato plants.

Conclusions

- Plant Probiotics, the microbial fertilizer with the smallest variety of microorganisms, resulted in the greatest percent change in height over time.
- A microbial fertilizer with a small variety of microorganisms resulted in a higher percent change in height over time than a microbial fertilizer with a large variety of microorganisms.
- Microbial fertilizers do not yield the same results in terms of growth as a chemical fertilizer in this case Miracle Gro.
- Microbial fertilizers do have an effect on the growth of tomato plants in terms of height over time.
- Since it was found that microbial fertilizers with a small variety of microorganisms have an effect on plant height over time, further research could be done to find more effective microbial fertilizers to replace chemical fertilizers.

Acknowledgments

- Dr. Michael Simini, Biological Scientist
- Mr. Larry Sickels, STEM Lead Teacher at Perryville High School

References

Title  Quorum Sensing Inhibition in Vibrio fischeri

Summary
In this investigation the effect of Tea Tree and Eucalyptus Essential Oils on the cellular process quorum sensing was tested in V. fischeri. This bacteria exhibits bioluminescence by using quorum sensing to detect a population threshold. After successfully culturing V. fischeri in a photo bacterium broth solution, the oils were added and the effect on bioluminescence was recorded using low-light imaging technology.

These images were then put through a photo analysis software to determine the change in light in each image. The results were inconclusive as only one trial was able to be tested due to the COVID-19 pandemic. The null hypothesis failed to be rejected, leaving this investigation up to future researchers who may be able to complete this with more trials.
Quorum Sensing Inhibition in *Vibrio Fischeri*

Michael Olszewski
PLTW Biomedical Sciences Program
Perryville High School

Abstract:
In this investigation, the effect of Tea Tree and Eucalyptus Essential Oils on the cellular processes quorum sensing was tested in *V. fischeri*. This bacteria exhibits bioluminescence using quorum sensing to detect a population threshold. After successfully culturing *V. fischeri*, a photochemiluminescence broth solution, the oils were added and the effect on bioluminescence was noted. Using live/dead cell technology, these images were then put through a photo analysis software to determine the change in light in each image. The results were inconclusive as only one trial was able to be tested due to the COVID-19 pandemic. The null hypothesis failed to be rejected, leaving this investigation up to future researchers who may be able to complete this with more trials.

Introduction:
*Vibrio fischeri* is a marine bacteria with bioluminescent properties. This bacterium uses quorum sensing to detect population density in the water, and will glow in the dark in ideal conditions if the population of bacteria reaches a certain capacity (1). Quorum sensing is based on chemical called autoinducers, that act as the main signaling molecule that bacteria use to communicate. These autoinducers are detected by receptors on the surface of the bacteria. These receptors initiate a signal transduction pathway that eventually results in the activation of genes (2). In the case of *Vibrio fischeri*, the protein luciferase is produced, which causes bioluminescence. However, protein production initiated by quorum sensing in bacteria that cause disease in humans may lead to increased biofilm production, and virulence factors contributing to the infection. Quorum sensing inhibition (anti-quorum sensing) is a potential novel way to prevent the development of and/or treat disease caused by infectious bacteria.

Essential oils are concentrated natural oils derived through the distillation of plants. Some widely used plants are lavender, tea tree, eucalyptus, lemon, and peppermint. The process for distilling the oils includes water and heat, and has been done for centuries. A simple double-boiler, and whichever plants you plan on distilling are all that is required to make essential oils. These oils are the pure essence of the plant and contain no other added ingredients. Essential oils are toxic to be inhaled or applied to the skin, not ingested. As used in aromatherapy, essential oils are used to have anxiolytic, anti-depressant, and anti-microbial properties. Some believe that essential oils have healing and antibacterial properties, and they have been used for generations as a form of homeopathic medicine.

Hypotheses:
Null Hypothesis: There is no significant relationship between essential oils and quorum sensing in the bacteria.

Alternative hypothesis: The use of essential oils on *V. fischeri* will have a significant change in the bioluminescence of the bacteria.

Methods:

**Procedure (Photobacterium Broth Handling and Creation):**
1. Take 3g of *photobacterium* broth powder, measured on an accurate scale, and in a 500ml endermeyer flask, mix together with 500 ml of disinfected water.
2. Use a stirrer to mix well. Try to eliminate any clumping in the broth.
3. Place a piece of filter paper wrapped around the top of the flask. Ensure it is completely covering the top.
4. Add 1 lb of distilled water to the autodilut. Set for 15 min.
5. Place the flask into the autodilut, close the lid, and press start.
6. Once the autoclave is complete, allow the flask to cool for at least 10 minutes, allow time to cool, then use with bacteria.
7. This can last up to 3-4 weeks if stored properly.

**Procedure (Trials):**
1. Fill each broth with 10ml *photobacterium* broth.
2. Label 3 beakers for each group. Tea tree oil, eucalyptus oil, and distilled water are the three groups.
3. Use a pipette to take 1 ml of *V. fischeri* broth and drop it slowly inside one of the 3ml *photobacterium* beakers. Do this for each beaker, using a new pipette each time.
4. Using aseptic technique, clean three stirrer pellets (one for each beaker), and let air dry. Once dry, place one pellet into each beaker gently.
5. Take one square inch of parafilm and use your hands to mold it onto the top of the beaker. Do not fully cover the beaker, but rather leave a small gap.
6. Set the beakers on a stirrer to the lowest speed inside the dark room testing space (preferrably a closet with no windows).
7. Check back 24 hours later.
8. Once the bacteria are glowing, set up the camera focusing on the beaker (still in total dark). The Camera ISO must be set at 640, and the shutter speed must be at 10 seconds.
9. Take an image of the beaker before adding anything, and ensure the image is clear. Next, set a stopwatch, add 50ul of tea tree oil to the beaker, and immediately begin the stopwatch. After 30 seconds, take a picture. Again at 1 minute, 1 minute and 30 seconds, 2 minutes, and after 5 minutes add the last 50ul, and take an image. Repeat with eucalyptus oil and distilled water.
10. Record all data and interpret results.

**Results:**
In this investigation, only one trial was able to be completed due to time operations being tardy for *V. fischeri* growth. In this trial, both tea tree and eucalyptus oils allowed a drastic decrease in light visible in the eye minutes after being added to the bacteria solution. This was not supported by the numbers in the photo-analysis software but can be visibly seen in the pictures taken during exposure.

**Discussion:**
The first trial that was conducted was with tea tree oil. Everything was done in complete darkness and the only light source was a phone light used to see the correct measurements for the microscope. The culture was glowing very vividly and as such as the oil was added there was a visible decrease in light emitted from the beaker. The imaging software used to analyze the pictures taken found an insignificant percent change in the light emissions, but after close observation, I believe that this software is not as accurate as previously thought, because the change in light was very visible to the eye in person and in images. Some similar results occurred with the use of eucalyptus oil in the beaker. One difference noted was that the light seemed to dim much quicker in person and in the photos taken when using the eucalyptus oil. Again, this was not shown in the imaging analysis software. I believe that the software is not accurate. The numbers given are what was used though, due to time constraints with the project. It is safe to say that this investigation should be refined in the future to gather more data and potentially incur new findings.

**Conclusion:**
After one trial of eucalyptus and tea tree oils, we failed to reject the null hypothesis. There were not enough trials conducted to come to a solid conclusion as to if essential oils can inhibit quorum sensing.

**Acknowledgements:** I would like to thank Mr. Sickels for providing the material, guidance, and support for doing this investigation. I would also like to thank Nicole McKee for all her extensive knowledge on essential oils and her guidance in my project.

**References:**
Title  The Horizontal Transfer and Incorporation of Plasmid DNA from S. volutans into B. bacteriovorus

Introduction:
*Bdellovibrio* bacteriovorus (*B. bacteriovorus*) is a predatory, gram negative bacteria that will hunt with “wolf pack” predation, not harm human cells and could eliminate 99.99% of the pathogen.

- Plasmid DNA can carry DNA that produces specific toxins. If it were to transfer, then there would be no reason to use predatory bacteria as an antibiotic method since the toxin would start to be produced by the predatory bacteria.

Conclusion:
1. *B. bacteriovorus* has failed to consume the *S. volutans*
2. There has been horizontal transfer of the plasmid DNA during predation
3. There is no horizontal transfer of the plasmid DNA during predation
The Horizontal Transfer and Incorporation of Plasmid DNA from *S. volutans* into *B. bacteriovorus*

Nicholas Peterson

STEM Academy, PLTW Biomedical Science Program, Perryville High School, CCP5

Introduction

- *Bdellovibrio bacteriovorus* (B. bacteriovorus) is a predatory, gram-negative bacterium that will hunt with “wolfpack” predation [1].
- *B. bacteriovorus* does not harm human cells [2].
- *B. bacteriovorus* interacts with its prey, consuming it from the inside, forming a bdelloplast (a *B. bacteriovorus* invagination cell), replicating, and finally bursting out killing the host [3].
- There is no chromosomal horizontal transfer from the prey to the *B. bacteriovorus*. The horizontal transfer of plasmid DNA is unknown.
- Chromosomal DNA is DNA that is within the nucleus.
- Plasmid DNA is a part of the plasmid, a ring of additional DNA floating in the cytoplasm.
- *B. bacteriovorus* wouldn’t eliminate all of the infectious pathogens, but with a high enough dose, it could eliminate 99.96% of the pathogens.
- Plasmid DNA can carry DNA that produces specific toxins. If it were to transfer, then there would be no reason to use predatory bacteria as an antibiotic method since the toxin would start to be produced by the predatory bacteria.

Hypothesis

- Alternative- There will be the incorporation of plasmid DNA into the predatory bacteria.
- Null- There will be no incorporation of plasmid DNA into the predatory bacteria.

Variables and Constraints

- The independent variable is the addition of *B. bacteriovorus*.
- The dependent variable is the incorporation of the PG80 amp plasmid, cultivated the transformed *S. volutans* (See above).
- On a nutrient agar plate, draw a line down the middle of the lid of the agar plate.
- Use one side with E. coli, the other with E+B.
- On each side, streak a strip (approx. 3 cm) of transformed S. volutans from the TSV tube with an inoculation loop.
- Blow dry the inoculated loop in a biosheath bag.
- Place the plate in an incubator at 30°C for 24 hours.
- After 24 hours, take the plate out and cover the E+B strip of *S. volutans* with *B. bacteriovorus* using a sterile tip micropette, using 50 μl of the colonies.
- Place the plate in an incubator at 30°C for 24 hours.
- Repeat step 2 & 3 every five minutes with separate plates.
- Examine for the presence of GFP under a black light and isolate on a slide to differentiate between the bacteria.

Methods

Cultivation Steps

1. For *S. volutans*, streak the given colonies onto a nutrient agar plate using an inoculating loop.
2. Put the plate in an incubator at 22°C for 48 hours.
3. For *B. bacteriovorus*, inoculate colonies into a nutrient broth flask.
4. Put the plate in an incubator at 30°C for 24 hours.

Transformation Steps

1. Using a sterile 1 ml pipet, add 0.5 mL of ice cold CaCl2 solution into the microcentrifuge tube labeled TSV and place on ice.
2. Transfer colonies from the *S. volutans* source to the TSV tube using an inoculating loop.
3. Resuspend the mixture by pipetting up and down the solution.
4. Add 15 μl of PGFP to the TSV tube, flick gently.
5. Incubate on ice for 15 minutes.
6. Place TSV tube into a dry bath at 42°C for 50 seconds.
7. Return TSV tube immediately into the ice bucket and incubate for two minutes.
8. Using a new pipet, add 250 μl of the recovery broth to the TSV tube, lightly flick the mixture.
9. Incubate the cells for 10 minutes at a 37°C water bath.
10. Use a sterile 1 ml pipet to transfer 250 μl of recovered cells to a labeled -AMP HTPC.
11. Spread the cells over the entire plate with a sterile inoculating loop.

Hypothetical Results

Due to Covid-19, school was cancelled and the experiment could not be completed. The researcher was able to get to cultivation and transformation. If there wasn’t the shutdown, the proper test would have been completed and data recorded. These are the results that could have occurred.

1. There is resistance with the presence of *S. volutans*.
2. There is resistance without the presence of *S. volutans*.
3. There is no resistance without the presence of *S. volutans*.

Discussion

- To disregard the null means there is shown resistance without the presence of *S. volutans*.
- To disregard the alternative means there is no resistance without the presence of *S. volutans*.
- A failure in either would be from an unexpected interaction between *S. volutans* and *B. bacteriovorus*.

Conclusion

1. *B. bacteriovorus* has failed to consume the *S. volutans*.
2. There has been horizontal transfer of the plasmid DNA during predation.
3. There is no horizontal transfer of the plasmid DNA during predation.

References

Title: Exploring Possible Safety Solutions for an Electrical Outlet

Introduction:
The United States has long been plagued by electrical outlet injuries to small children. According to both the Electrical Safety Foundation and Indiana Electric Cooperatives, report that over 2400 young children are sent to emergency rooms annually due to poor electrical outlet safety. When we polled high school teachers in our county about electrical safety and found that 30% of adults polled have had them or a family member shocked by an outlet. We planned on inventing or innovating on a product that will help address this issue. The market already has some products that attempt to address this issue, but they are cheap, and in some cases are completely ineffective. Our goal was to lessen the amount of injuries to small children in the United States caused by electrical outlets.
Exploring Possible Safety Solutions for an Electrical Outlet
Caleb P. Phillips and Andrew S. Wennersten
Honors Engineering Design and Development, Perryville High School

Introduction
The United States has long been plagued by electrical outlet injuries to small children. According to both the Electrical Safety Foundation and Indiana Electric Cooperatives report that over 2400 young children are sent to emergency rooms annually due to poor electrical outlet safety. Where we polled high school teachers in our county about electrical safety and found that 30% of adults polled have had them or a family member shocked by an outlet. We planned on inventing or innovating on a product that will help address this issue. The outlet already has some products that attempt to address this issue, but they are cheap, and in some cases are completely ineffective. Our goal was to lessen the amount of injuries to small children in the United States caused by electrical outlets.

Figure 1. Depicted is one of the safety products already on the market (Mommy’s Helper Outlets).

Materials and Methods
Our plan was to individually 3D print all thirteen of the parts, and then assemble them post production. This was right where we were before our process was interrupted by the COVID pandemic.

Our method to test our product was to attach our product to a disconnected outlet, and find willing parents to let their children be used for the experiment. These children would attempt to open the outlet and plug something in.

Figure 2. The image above depicts the first design of our prototype. Notably the design lacks springs on the buttons that allow them to close the outlet.

Figure 3.a/b/c show possible redesigns if the selected solution were to fail. All three use a lock system of some kind.

Plans for Results
As stated prior, the COVID pandemic affected our ability to create a final product. To test the effectiveness of our product vs the competitors, we would have had a group of small children try opening a variety of outlet safety devices, including our very own. We were going to time the children to see if our device was the hardest to understand and therefore open. Ideally the children would not have been able to open our outlet shelf at all, but we could not test this. If our product was not the most effective at preventing children from touching an outlet, we would have gone back to the drawing board and modified it to become the most effective. This might have meant changing the materials to be more durable while still maintaining a competitive price to produce.

Conclusions
Our project was sadly interrupted by the COVID-19 Pandemic right before the testing phase.
Our initial research looked very promising, that this was a product wanted by the market. As stated in the introduction, over 30% of teachers in the Cecil County Public Schools system have had an injury at home at the result of an electrical outlet. Applied to the 55 million families in the United States, this leads to about 25 million families who have seen an injury due to an electrical outlet in their own home.
As promising as the initial research showed, no actual conclusions can be drawn because of the lack of testing.

Literature Cited

Acknowledgments
We thank D. Kiel for acting as both a teacher and mentor for our project. His insight and knowledge were key to our group’s success. We also thank the Electrical Safety Foundation International (ESFI) for answering specific questions we had about proper safety regulations.

For further information
Please contact Caleb Phillips or Andrew Wennersten at Perryville High School, 1696 Perryville Rd, Perryville, MD 21903.
Title  
Innovative and Re-imaging Utensils for Efficient Handwriting

Introduction
81% of all people claim to have bad handwriting. All around the world, in any school setting, the people attending them often struggle with horrific handwriting. Our idea was to create a utensil, aiding children through young adults as they enhance their handwriting to become more efficient and an overall neater projection of their writing.

Further Plans/Conclusion
At this point, we were halted in finishing our project due to COVID-19. We were in the process of beginning to 3D print while finding the correct material as far as foam. Our extended plans included developing a rough and finalized product, made entirely out of 3D material and authentic foam until we were satisfied with the outcome.
Innovative and Re-imaging Utensils for Efficient Handwriting
Alexander Reynolds and Eddie Hansen
Honors Engineering Design and Development, Perryville High School

Introduction
81% of all people claim to have had handwriting. All around the world, in any school setting, the people attending them often struggle with horrific handwriting. Our idea was to create a utensil, aiding children through young adults as they enhance their handwriting to become more efficient and an overall neater projection of their writing.

Prior Info and Past Solutions
In this stage, we researched past attempts at a similar product idea. We researched patent ideas for guidance and information surrounding our initial idea. Our group found several similar ideas with in-depth detail. However, these products were very expensive and highly intricate, to which we were forced to change paths of our product idea.

Initial Destination
Our projected idea at the beginning of this assignment was to create a free air writing pen, used in a form of a projector, possibly a smartboard which are located in most classrooms. This pen would allow the user to write in the air with the device, projecting the print with automatic alteration of the writing through coding to allow the user to improve their handwriting.

Project Idea
As it came down to the production of our actual product we decided to create a foam pencil. This idea acts as a fully functional utensil with the outer shell remaining as foam, which molds to the user’s fingers in result of efficient handwriting and the overall improvement of the individuals print.

Further Plans/Conclusion
At this point, we were halted in finishing our project due to COVID-19. We were in the process of beginning to 3D print while finding the correct material as far as foam. Our extended plans included developing a rough and finalized product, made entirely out of 3D material and authentic foam until we were satisfied with the outcome.

Figure 1. The first organization our group discovered to lead us on the correct path with our project: International Graphophysics Society

Figure 2. This image was discovered during our project research project, which incorporated an axis which would be essential for the product we were attempting to create.

Figure 3. The image above is also from our patent research assignment, in which the pressure of the user reflects the efficiency of the outcome.

Figure 4. Above resides our first written projected prototype as we thoroughly plan out the design of our product. Shown above is a standard 0.5mm BIC mechanical pencil wrapped in foam.

Protootyping
During our prototyping, we planned on 3D printing the base utensil and were unsure of the type of foam to use for our final product. When creating our actual prototype, we wrapped a standard BIC mechanical pencil in foam found on school property that closely resembles the ideal foam for our final product.

Figure 5. Our prototyped foam pencil

Figure 6. Above is the dimensions of the standard BIC mechanical pencil that was destined to be recreated through 3D print.

Literature Cited

Acknowledgments
We thank Daniel Keil for his support throughout this pandemic and overall throughout our school career within our engineering class.
Title  Toe Protection

Introduction
Our product, The Toe Turtle, is a solution to a common problem in high intensity sports. This problem is toe injuries. We conducted surveys in five different high schools around our area. The results overwhelmingly proved that there is demand for a product that both protects athletes toes, and is comfortable.

Conclusions
The Toe Turtle is an effective product that offers good protection from toe injuries, with ease of use. It filled a need for athletes who want extra protection for their toes. It is cost effective and easy to make. It is also extremely customizable so it can fit all different kinds of cleats. Because of the current circumstances we did not get to actually do the testing.
**Introduction**

Our product, *The Toe Turtle*, is a solution to a common problem in high-impact sports. This problem is toe injuries. We conducted surveys in five different high schools around our area. The results overwhelmingly proved that there is demand for a product that both protects athletes toes, and is comfortable.

This is the Toe Turtle prototype. It failed halfway through the 3D print; it is supposed to arch at the top.

**Materials and methods**

The Toe Turtle would have made out of high impact polystyrene. This material provides a high resistance to impacts however it is also cheap to get and can be formed into whatever shape is needed to fit the size of the foot.

The Toe Turtle would be thermformed into a shell of high impact polystyrene. This process is easy to do and can be repeated quickly and at a high efficiency. This makes it far superior to 3D printing or casting.

**Hypothesized testing and results**

Our testing was going to include three different tests, a flexibility test, a hammer drop test, and a functionality test.

**Flexibility test:**

In this test the Toe Turtle would be placed in a device that would allow it to different degrees. We would test its ability to flex but also return to its original shape. We hypothesize that our product would do the worst in this test, as flexibility was kept in mind for its design but impact resistance is its primary goal.

**Hammer drop test:**

In this test the Toe Turtle would be held in place on the ground. A hammer would then be dropped from 1, 3, 6 feet. This would test the impact resistance with different levels of impact. We hypothesize that the Toe Turtle would do very well in this test. Due to the half dome shape of the toe guard section of the Toe Turtle it would have been highly resistant to impacts with high force.

**Functionality test:**

In this test an athlete would wear it and perform different kinds of physical movement. A sprint and agility, the results would be gathered from the athletes feedback on how the toe turtle feels and acts.

We hypothesized that the test would be successful and the athlete would not notice the toe turtle after the first few minutes with it in their cleat.

**Conclusions**

The Toe Turtle is an effective product that offers good protection from toe injuries, with ease of use. It filled a need for athletes who want extra protection for their toes. It is cost effective and easy to make. It is also extremely customizable so it can fit all different kinds of cleats. Because of the current circumstances we did not get to actually do the testing.

**Literature cited**

US patent #20190350273  
US patent #20190350273  
US patent #7367074B1  
US patent #20090255147A1

**Acknowledgments**

Daniel Knevel  
Michael Likner

**For further information contact**

tenchr0455@cscc.org  
nichromoz24603@cscc.org

**Figure 2.** This is an example of a thermomforming machine, the sheet of material is heated until it is flexible. Then it is dropped onto a mold of the product. A vacuum is then pulled and the hot material is pulled over the mold and it cools, resulting in an exact replica of the mold.
Title  Efficacy of Antimicrobial Sheets

Summary
This project was designed to test the central question of whether silver threaded sheets actually prove to be more effective at preventing bacterial growth than normal cotton blend sheets. The sheets with silver thread claim to reduce bacterial growth since silver has antimicrobial properties.

In order to test this, both cotton blend and silver threaded sheets were marked out with rings to measure growth and exposed to E.coli bacteria and then incubated so that the bacterial growth could be measured.

The results were rather inconclusive, however the data that was collected did indicate that silver did grow less, however it did not seem to be significantly substantial. The conclusion is unfortunately rather inconclusive due to limited data, however, based on what was collected, one could hypothesize that the silver threaded sheets are slightly more effective than the cotton blend.
Efficacy of Antimicrobial Sheets
Elizabeth Rovine
PLTW Biomedical Sciences PVHS

Abstract
This project was designed to test the central question of whether silver thread sheets actually prove to be pasteurization alternatives for cotton blend sheets. The sheets with silver thread claim to reduce bacterial growth since silver has antimicrobial properties. In order to test this, both cotton blend and silver thread sheets were tested using two types of standard test tubes and exposed to E.coli bacteria and then incubated so that the bacterial growth could be measured. The first set contained control sheets, and the second set were silver thread sheets. The results were rather inconclusive. However, the data that was collected indicated that silver did inhibit bacterial growth in the silver thread sheets. The data was collected on limited time frame but could hypothesize that the silver thread sheets were slightly more effective than the cotton blend.

Introduction
Your bedsheet to constantly be used, which means they get dirty very fast. Due to constant use, bacteria builds up within the bed sheets. (5)
In order to reduce bacterial growth, antimicrobials are often used. Antimicrobials are natural or manmade substances that control bacterial growth.
Silver is often used as an antimicrobial, for example in wound dressings (4), so sheet companies used it to create silver thread sheets. The overall question is are these sheets actually effective, or worth the money. Ideally, the antimicrobial sheets will be more effective at reducing bacterial growth.

Hypotheses & Constraints
• Alternative Hypothesis: The Miracle Brand sheets will have less bacterial growth than the cotton blend sheets because the silver thread used in them has antimicrobial properties.
• Null Hypothesis: There will be no difference in the bacterial growth in both sheets.
• Constraints include time limits, resources, and difficulty analyzing the actual data.

Methods
Prep sheets by cutting them into squares that are roughly 1.5 cm x 1.5 cm. Then, take a ruler and a Sharpie marker and mark the middle of the sheet. Then, use a pair of scissors to cut the paper to the middle. Then, place the sheets in a Petri dish and then place in the center of the sheet. Place the sheets carefully onto an empty plastic plate and then place on the bottom of the Petri dish. Then, add 0.5 ml of the tape with the control sheets and then allow to sit in a 37°C temperature area for 15 minutes. Then, add 6.25 ml of the tape with the control sheets and then allow to sit in a 37°C temperature area for 15 minutes before allowing it to cool and plate.

Results
There were no quantifiable results but based on the qualitative results (images below), it could be hypothesized that the silver was indeed more successful at reducing bacterial growth. This result is not conclusive, however.

Discussion
- There were several inconsistencies in timing during this project. A few days in incubation could’ve been adjusted in order to prevent that.
- There were several issues in methodology that required it to be changed multiple times until something worked.
- The school was shut down due to COVID-19 concerns, so data was not collected and finished properly, leaving results inconclusive. There was no way to finish getting data or verifying proper methodology.
- There could’ve been more concise methods, in order to get the fastest, most effective data.
- There could have been safer handling in order to reduce bacteria exposure to the sheets before the testing began on them.

In the future, one could expand this project by experimenting on different types of sheets, or with bacteria more commonly found in the body, for example, somebody could investigate Egyptian blinds sheets versus “Bamboo blend sheets” and the silver sheets again. This could provide a more comprehensive view of what materials are safer and most cost effective. Using bacteria from the body could allow for more realistic results.

References
- Ghazzar, G., Yoo, Seok, S., Kunkle, F. M., Grainger, M. S. (2019). Wound Dressings. Retrieved from

Acknowledgements
I would like to thank Mr. Larry Sickels, my PLTW instructor, and Ms. Nicole McChew, my mentor.
Title: The Effect of Red Bull Energy Drinks on the Growth of *Escherichia coli*

Summary: This investigation attempts to find if there is a relationship between Red Bull energy drinks and *Escherichia coli* bacteria that resides in the human intestines and assists the immune and digestive system.

Most are aware of the known side effects of energy drinks, such as heart issues, however, this study takes a deeper look at its issues. Red Bull at various types and temperatures is added onto plates streaked with *E. coli*. After growth, results were recorded and analyzed to reveal significant data showing that Red Bull decreases this bacteria’s ability to grow.

This finding indicates more effects of energy drinks, ones that can be implied to more than just cardiovascular health.
The Effect of Red Bull Energy Drinks on the Growth of *Escherichia coli*

Isabella Simon

PLTW Biomedical Science, Perryville High School

**Abstract**

This investigation attempts to find if there is a relationship between Red Bull energy drinks and *Escherichia coli* bacteria that resides in the human intestines and assists the immune and digestive system. Most are aware of the known side effects of energy drinks, such as heart issues; however, this study takes a deeper look at its issues. Red Bull at various types and temperatures is added onto plates streaked with *E. coli*. After growth, results were recorded and analyzed to reveal significant data showing that Red Bull decreases this bacterium’s ability to grow. This finding indicates more effects of energy drinks, ones that can be implied to more than just cardiovascular health.

**Introduction**

- *E. coli* is a bacteria that colonizes the human gastrointestinal tract that is known to be highly beneficial to multiple human body systems (Kumar, 2014).
- Damage to this bacterium could cause infection, disease, cell injury, and more detrimental issues (Kumar, 2014).
- Red Bull energy drinks for instance, are known to have numerous harmful effects on the body including damage to the intestines (Parikh, 2008), and serious heart complications (McGrane, 2019).
- This investigation studies how energy drinks impact the growth of *E. coli*.

**Hypothesis**

H₀: Red Bull energy drinks will have no impact on the growth of *E. coli.*
H₁: Red Bull energy drinks will decrease the growth of *E. coli.*

**Methods**

25 Agar plates prepared and left to solidify.

Plates streaked with *E. coli*.

Red Bull is added and plates are incubated.

**Results**

- **Red Bull on *E. coli* Growth**
  - Percentage of Growth
  - Type and Temperature

- **Number of Groups: 0.000042** Significant.
- **P-value for temperature of Original Red Bull: 0.47556** Insignificant.
- **P-value for temperature of Sugarfree Red Bull: 0.039521** Significant.
- **P-value for Original compared to Sugarfree: 0.013242** Significant.

**Conclusions**

- Red Bull energy drinks significantly disrupt *E. coli* growth in the human intestines.
- Temperature of Red Bull Original has no impact on growth.
- A higher temperature of Sugarfree Red Bull increases growth.
- Sugarfree Red Bull increases growth when compared to Original Red Bull.

![Graph showing growth of *E. coli* with different temperature and Red Bull](image)

![Image of plates with streaked *E. coli*](image)

**Discussion**

Based on the data, the found p-values, and their significance, the null hypothesis of this investigation can be rejected with confidence. This outcome can be explained by the ingredients and chemicals in energy drinks that affect the digestive and immune systems, as mentioned in the introduction. Sugarfree Red Bull displaying more growth compared to the Original Red Bull can be explained by previous findings that artificial sweeteners increase bacterial growth (Artificial Sweeteners…2018). Energy drink consumers should consider these results and the effects on their health; however, it can be seen that consuming Sugarfree Red Bull would lead to less of an impact on bacterial growth.

**Acknowledgements**

Mrs. Nicole McKee, APG, Aberdeen, Maryland
Mr. Larry Sickels, Perryville High School

**References**

Title  The Effect of Exposure Time of Over The Counter Liquid Medicine on Salivary Amylase

Summary
This project has the purpose to find out if exposing over the counter liquid medicine for a certain amount of time can affect digestion.

Digestion starts in the mouth with the enzyme amylase which breaks down carbohydrates to make glucose. If affected it could cause the body not to obtain the raw materials needed. The test was performed by mixing amylase with either Mucinex or Nyquil and then mixed with a carbohydrate (saltine crackers). The mixture gets tested for traces of glucose after 60 seconds, 120 seconds, 180 seconds, 210 seconds, 240 seconds, 270 seconds and 300 seconds. The exposure time variable had no significance and did not affect amylase while the type of medicine did. Nyquil had a great amount of glucose when tested but Mucinex had no traces of glucose. The ingredient Guaifenesin found in Mucinex affects amylase, this means some types of medicine do affect digestion.
The Effect of Exposure Time of Over The Counter Liquid Medicine on Salivary Amylase

Grace Hope Stevens
Perryville High School
PLTW Biomedical Science and CCPS STEM Academy

Abstract:
This project has the purpose to find out if exposing over the counter liquid medicine for a certain amount of time can affect digestion. Digestion starts in the mouth with the enzyme amylase which breaks down carbohydrates to make glucose. If exposed it could cause the body not to obtain the necessary glucose needed. The test was performed by mixing amylase with either Mucozym or NyQuil and then mixed with a carbohydrate (sliced crackers). The mixture was mixed for 0, 60 seconds, 120 seconds, 180 seconds, 240 seconds, 270 seconds and 300 seconds. The exposure time variable had no significance and did not affect amylase while the type of medicine did. NyQuil had a great amount of glucose when used but Mucozym had no traces of glucose. The ingredients found in medicines affects amylase, this means some types of medicine do affect digestion.

Methods:

Introduction:
- Mucozym® and NyQuil® are over-the-counter (OTC) liquid medicines that are taken orally and may affect the biochemistry of the mouth, specifically the enzymes.
- Salivary amylase is an enzyme that catalyzes complex carbohydrates (e.g., polysaccharides), such as starch, into simple carbohydrates (e.g., monosaccharides), like glucose.
- Not all carbohydrates are broken down in the mouth; digestion of starches does begin in the mouth. Salivary amylase functions better than the amylase in the small intestine, liver and pancreas [1]. If salivary amylase is not present then the amylase elsewhere would have to break down more carbohydrates in order to have the normal amount of complex carbohydrates in the body.
- After a liquid medicine is consumed it leaves residue in the mouth that could continue to affect enzymes even after the medicine has been swallowed. Thus the longer that the enzymes are exposed to the OTC liquid medicine, the greater the chance are that the enzyme would be affected.

Hypothesis:
- Alternative Hypothesis: the greater the time exposure and the brand of medicine will result in decreased function of amylase.
- Null Hypothesis: time exposure and the brand of medicine will have no effect on the function of amylase.

Discussion:
- NyQuil had carbohydrates in it before the experiment is why NyQuil had high traces of glucose compared to the control group during the test.
- Mucozym had no carbohydrates in the medicine before the experiment, this is why Mucozym had no traces of glucose during the experiment.
- Mucozym also has an ingredient called guar gum known to interfere with amylase levels [2].

Results:

Conclusion:
- The One-Way ANOVA test between the Means, NyQuil and Control group for the time variable had a p-value of .99789. Since this value is greater than the p-value of .05, we fail to reject the null hypothesis.
- The One-Way ANOVA test between the Means, NyQuil and Control group for the type of medicine variable, had a p-value of .00001. Since this is lower than a p-value of .05, the null hypothesis is rejected.
- The independent T-Test between Means, Mucozym and NyQuil for the type of medicine variable has a p-value of .00001. Since this is lower than a p-value of .05, the null hypothesis is rejected.
- The independent T-Test between the Control group and NyQuil for the type of medicine variable has a p-value of .00001. Since this is lower than a p-value of .05, the null hypothesis is rejected.
- The independent T-Test between Means, and the Control group for the type of medicine variable has a p-value of .00012. Since this is lower than a p-value of .05, the null hypothesis is rejected.

Acknowledgments:
- A thank you to all who helped contribute to the experiment including Hunter Arledge, Torina Bolden, Alvin Coggins and Tyroni Mooman.
- A special thank you to Larry Sauls, my mentor and teacher answering any question I had.
- Thank you to Perryville High School for allowing me to use the facilities to do the experiment.

References:
Title  The Effectiveness of Phage Therapy Compared to Antibiotics on Resistant/Non-resistant E.coli and Bacillus Subtilis

Summary
For this experiment, the effects of Phage therapy and antibiotics on the growth of resistant/non-resistant E.coli and Bacillus Subtilis were explored.

The purpose of this experiment was to explore which treatment method prohibited the growth of each of the bacteria most effectively. When antibiotics are administered, they target the bacteria, they destroy the cell wall, and prevent cell reproduction. They enter the body most commonly through the mouth and target the bacterial cell. However, bacteria becomes resistant not when the antibiotics stop working but when the bacteria begin to evolve and fight off the antibiotics (CDC, 2020). For this reason, other alternatives need to be explored such as phage therapy.

Throughout the experiment, results showed antibiotics however worked the best in preventing the growth of E.coli and Bacillus Subtilis by a significant value.
The Effectiveness of Phage Therapy Compared to Antibiotics on Resistant/ Non-resistant E.coli and Bacillus Subtilis

Arianna Varela

PLTW Biomedical Science Program, Perryville High School

Abstract

For this experiment, the effects of Phage therapy and antibiotics on the growth of resistant/ non-resistant E. coli and Bacillus Subtilis were explored. The final project consisted of 36 plates, each with 3 sterile disks approximately 0.5 cm in diameter. The purpose of this experiment was to explore which treatment method prohibited the growth of each of the bacteria most effectively. When antibiotics are administered, the bacteria are killed. This experiment allowed the bacteria to destroy the cell wall and prevent cell reproduction until the body is most commonly through the receptors and target the bacterial cell. However, bacteria become resistant not when the antibiotics stop working but when the bacteria begin to evolve and fight off the antibiotics (CDC, 2020). For this reason, other alternatives need to be explored such as phage therapy. Throughout the experiment, the results showed antibiotics however worked the best in preventing the growth of E. coli and Bacillus Subtilis in a significant value.

Introduction

- Explore the use of the T4 bacteriophage on resistant and non-resistant bacteria in comparison to more traditional treatment options (i.e. antibiotics).
- Results from this investigation will lead to new research on treating E. coli and B. subtilis.

Hypothesis

Alternative hypothesis: Phage therapy will be more effective at preventing the growth of bacteria compared to antibiotics.

Null Hypothesis: Phage therapy will not be any more effective at preventing the growth of bacteria compared to antibiotics.

1. Obtain 36 sterile disks each 6 mm in diameter and soak a vial of T4 Phages.
2. Obtain a 250 mL beaker and fill it up to 100 mL with distilled water.
3. Using LH agar powder, obtain a scale and a weight and measure out 3.5 g of the powder then pour this into the 250 mL beaker from step 2. Stir until the solution and place in the microwave for 36 seconds or until the powder has fully dissolved and the beaker is translucent.
4. Repeat steps 1-3 for B. subtilis, antibiotic resistant E. coli strain 1 and 2.
5. In the end, there will be a total of 36 plates, 24 plates with antibiotics and 12 plates as the control groups for each bacterium.
6. Obtain a pair of forceps or fine and remove the T4 phage-soaked disks one by one letting each disk dry for 5 seconds. Plate each disk in a triangular form around the petri dish using aseptic techniques to avoid contamination. On all plates of T4 phages have been completed, sanitize and wash the forceps.
7. Then begins planting the antibiotic dishes sanitizing the forceps between each new antibiotic with 3 disks on each plate and placing in a triangular form.

For the first one-way ANOVA 1 used regular E. coli phages and regular E. coli: Tetrazycline plates. The p-value came to be .0001 meaning the data is statistically significant. The p-values of all the phage and antibiotic plates for Bacillus Subtilis and the resistant strain 1 and 2 of E. coli came to be .0001. This means the difference between phages and antibiotics on the growth of bacteria is statistically significant; this can be seen in the visible results of the experiment as well.

Discussion

The purpose of this project is to identify which treatment (phage therapy or antibiotics) is more effective on the growth of Bacillus Subtilis and E. coli resistant and non-resistant bacteria. Conclusions is overall antibiotics left a larger zone of inhibition than the T4 phages. Using this project may open up opportunities allowing others to learn which method more effectively treats the bacteria for use in the medical field. Limitations were the time limit, and the cost of the materials such as T4 phages and antibiotic disks. A Possible Source of error is the viability of the T4 phages.

Conclusion

- Overall antibiotics left a larger zone of inhibition than the T4 phages.
- Repeats my hypothesis of the phages leaving a larger zone of inhibition than the antibiotics.

References


Acknowledgments

I would like to thank Larry Sickets' course director and Vanessa Richards my mentor for all their guidance and help.
Title  Exploring Possible Safety Solutions for an Electrical Outlet

Introduction
The United States has long been plagued by electrical outlet injuries to small children. According to both the Electrical Safety Foundation and Indiana Electric Cooperatives report that over 2400 young children are sent to emergency rooms annually due to poor electrical outlet safety. When we polled high school teachers in our county about electrical safety and found that 30% of adults polled have had them or a family member shocked by an outlet. We planned on inventing or innovating on a product that will help address this issue. The market already has some products that attempt to address this issue, but they are cheap, and in some cases are completely ineffective. Our goal was to lessen the amount of injuries to small children in the United States caused by electrical outlets.
Exploring Possible Safety Solutions for an Electrical Outlet

Caleb P. Phillips and Andrew S. Wennersten
Honors Engineering Design and Development, Perryville High School

Introduction
The United States has long been plagued by electrical outlet injuries to small children. According to both the Electrical Safety Foundation and Indiana Electric Cooperatives report that over 2400 young children are sent to emergency rooms annually due to poor electrical outlet safety. When we polled high school teachers in our county about electrical safety and found that 30% of adults polled had had them or a family member shocked by an outlet. We planned on inventing or innovating on a product that will help address this issue. The outlet already has some products that attempt to address this issue, but they are cheap, and in some cases are completely ineffective. Our goal was to lessen the amount of injuries to small children in the United States caused by electrical outlets.

Plans for Results
As stated prior, the COVID pandemic affected our ability to create a final product. To test the effectiveness of our product vs the competitors, we would have had a group of small children try opening a variety of outlet safety devices, including our very own. We were going to time the children to see if our device was the hardest to understand and therefore open. Ideally, the children would not have been able to open our outlet shelf at all, but we could not test this. If our product was not the most effective at preventing children from touching an outlet, we would have gone back to the drawing board and modified it to become the most effective. This might have meant changing the materials to be more durable while still maintaining a competitive price to produce.

Materials and methods
Our plan was to individually 3D-print all thirteen of the parts, and then assemble them post production. This was right where we were before our process was interrupted by the COVID pandemic.
Our method to test our product was to attach our product to a disconnected outlet, and find willing parents to let their children be used for the experiment. These children would attempt to open the outlet and plug something in.

Figure 1. Depicted is one of the safety products already on the market (Mommy’s Helper Outlets).

Figure 2. The image above depicts the first design of our prototype. Notably the design lacks springs on the buttons that allow them to close the outlet.

Figure 3a/b/c show possible redesigns if the selected solution were to fail. All three use a lock system of some kind.

Conclusions
Our project was sadly interrupted by the COVID-19 Pandemic right before the testing phase.
Our initial research looked very promising, that this was a product wanted by the market. As stated in the introduction, over 30% of teachers in the Cecil County Public Schools system have had an injury at home at the result of an electrical outlet. Applied to the 85 million families in the United States, this leads to about 25 million families who have seen an injury due to an electrical outlet in their own home. As promising as the initial research showed, no actual conclusions can be drawn because of the lack of testing.

Literature cited

Acknowledgments
We thank Dr. Kiel for acting as both a teacher and mentor for our project. His insight and knowledge were key to our group’s success. We also thank the Electrical Safety Foundation International (ESFI) for answering specific questions we had about proper safety regulations.

For further information
Please contact Caleb Phillips or Andrew Wennersten of Perryville High School
2660 Perryville Rd, Perryville, MD 21903
Title  
SecurzAll an Innovative Safety Solution to Prevent Scaffolding Accidents Related to Falling Objects

Problem Statement
In a 2009 study conducted by the Occupational Safety and Health Administration, 72% of workers injured in a scaffolding accident listed being “struck by a falling object” as one of the leading causes for their accident. Another 2010 OSHA study confirms that being struck by an object is the second leading cause of death in the construction industry, accounting for 11.2%, amounting to 112 fatalities annually. The accidents can be attributed to tools and equipment not being safely secured when not being utilized.

Conclusions
This is very difficult to do, since we unfortunately could not complete this project. However, I would predict that the SecurzAll functions very well.
SecurzAll an Innovative Safety Solution to Prevent Scaffolding Accidents Related to Falling Objects

Dylan Whitney
Honors Engineering Design and Development, Perryville High School

Problem Statement
In a 2009 study conducted by the Occupational Safety and Health Administration, 72% of workers injured in a scaffolding accident blamed being "smacked by a falling object" as one of the leading causes for their accident. Another 2010 OSHA study confirms being struck by an object is the second leading cause of death in the construction industry, accounting for 11.2%, amounting to 112 fatalities annually. The accidents can be attributed to equipment and not being safely secured when not being utilized.

Product Description
The heavy-duty base of the SecurzAll is made of lightweight aluminum that houses magnetic surfaces, which securely hold tools and other gadgets keeping them within easy reach of the operator. Quick-release pipe clamps allow easy, quick and secure attachment of the SecurzAll to scaffolding. The center section of the SecurzAll is 4' long. It features two zippered extensions, 2' in lengths each, for a total of 8' of interior storage. 6 heavy-duty swivel hooks with safety latches increase the SecurzAll’s storage capability. The SecurzAll supports the 5-S initiative, which optimizes safety, efficiency and cost.

Operation
The SecurzAll system is easy to use and quick to install. It conveniently attaches with quick release pipe clamps to scaffold (guard rails, ledgers and transoms). Once the system is attached it can be used in its compact (4') or extended (8') form. The SecurzAll holds handheld tools, small parts and trinkets not currently being used while keeping them within easy reach of the operator. Larger items can be secured on the device by using the heavy-duty swivel hooks with safety latches.

Statement of Purpose
Lower accidents and fatalities by falling objects on scaffolding on construction sites.

Justification
Safety and safety precautions are integral components of a construction site. The SecurzAll system holds equipment securely and safely in place, preventing it from falling off scaffolding. Consequently, the SecurzAll greatly decreases the number of scaffolding accidents caused by falling objects. Eliminating the Fatal Four would save 591 lives in the US each year. Furthermore, avoiding accidents keeps the construction site operational and reduces costs linked directly and indirectly to construction accidents. According to OSHA, it offsets losses of $550,000 and arriving to make a profit of 3% a company makes on an additional 1,667,000,000 in services.

Figure 1. Infographic: "The Fatal Four"

Figure 2. Draft of SecurzAll

Figure 3. Prototype

Figure 4. SecurzAll with tools

Figure 5. SecurzAll secured to scaffold

Testing
The SecurzAll will be tested in situ at the simulated real life scenarios.
- Attached to scaffold (guard rails, ledgers and transoms)
- Loaded with 100 pounds of tools and equipment
- Repetition with 150-pound load
- Shake the scaffold vigorously
- Check quick-release pipe clamps
- Check swivel hooks
- Determine whether tools are moving/staying securely in place
- Check magnet strength (not several magnets)

Results
I never had an opportunity to build or test the product. However, I would predict the following results from the first test:
- I may have had to replace the magnets to increase their strength, based on test outcome.
- The consumer survey may also have revealed additional parameters for tools
- Initially, I designed the SecurzAll quick-release pipe-clamp on each extension. I predict that the results of the first test would have made me redesign and add an additional pipe clamp on each extension, for a total of 7 per unit.

Conclusions
This is very difficult to do, since we unfortunately could not complete this project. However, I would predict that the SecurzAll functions very well. The SecurzAll is a must-have for the safety-oriented enterprise. Get the your SecurzAll by your enterprise today to protect each member of your construction staff and secure your company’s success and assets. Limitations to our experiment would be that we only tested the product in a simulated scenario and not in a real-world construction setting. In order to evaluate the effectiveness of the SecurzAll and to be able to determine how the product would indeed reduce scaffolding accidents due to falling objects the product would need to be tested by at least one professional construction company or in a professional test laboratory/testing center over a certain period.

Literature Cited

For further information
Please contact dylanwhitney3233@gmail.com

Acknowledgement
This poster was created utilizing a template: http://www.wtamu.edu/ncsl1/psptguide/psptguide.html
RISING SUN HIGH
We recognize and congratulate these students from Elkton High School for completing their Capstone projects during extraordinary conditions.

<table>
<thead>
<tr>
<th>Honors Engineering Design &amp; Development</th>
<th>Honors Education Academy</th>
<th>Honors STEM Research &amp; Design Capstone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tyler Brown</td>
<td>Jordyn Keys</td>
<td>Sean Brady</td>
</tr>
<tr>
<td>Stuart Kotch</td>
<td>Eden Lied</td>
<td>Logan Brewer</td>
</tr>
<tr>
<td>Joshua Moskes</td>
<td></td>
<td>Avery Brooks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eva Cook</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bryson Crowl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thomas Dymowski</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Katie Gibson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Noah Jones</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dillon Nolan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sean Nolan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Christopher Oh</td>
</tr>
<tr>
<td>Honors Biomedical Innovations w/Lab</td>
<td></td>
<td>Matthew Renzo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nathan Sexton</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Benjamin Smith</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Charles Teague</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brianna Thornton</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Madeline Warnick</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jared Webb</td>
</tr>
</tbody>
</table>

Shyann Peterson
Title  The Effects of Addictive Substances on Planaria Torva Motility

Summary
This project uses planaria, which is a type of flatworm of the class Turbellaria that contain a nervous system and spinal cord (Britannica). They are also ideal for drug withdrawal research and addictive substance research according to Dr. Robert Raffa from Temple University and a Macquire University study.

The results from this experiment will help find a connection between addictive substances and motility to relate back to humans. This will give a little insight on the true effects of these substances and whether they should continued to be used or not. To conduct this experiment the planaria will be placed in well plates with the designated substance for the time allotted. Then, the planaria will be placed in a petri dish over a grid line and taped for 5 minutes. The video will be examined and the velocities of the planaria within those first five minutes will be examined to observe the immediate effects. This will be done 7 times over the course and the tolerance and addiction of the planaria will be observed.
The Effects of Addictive Substances on Planaria Torva Motility

Sean Brady
Rising Sun High School STEM Academy

Abstract
This project uses planaria, which is a flatworm of the class Turbellaria that contain a nervous system and spinal cord/brain tissue. They are used for drug withdrawal research and addictive substance research. A study was done by Dr. Robert Raffa from Temple University and a Macquarie University study. With this knowledge, the experiment was formed to see the effects of addictive substances. The results from this experiment will help find a connection between addictive substances and mobility to relate back to humans. This will give a little insight on the true effects of these substances and whether they should be used or not. To conduct this experiment, the planaria will be placed in well plates with the designated substance for the time allotted. Then, the planaria will be placed in a petri dish over a grid and taped for 5 minutes. The video will be examined and the velocities of the planaria within those first five minutes will be examined to observe the immediate effects. This will be done 7 times over the course and the tolerance and addiction of the planaria will be observed.

This diagram shows the neurobiology of addiction on the human brain. This can be used to relate the effects of these addictive substances on the brain.

Introduction
As stated previously, planaria are a type of flatworm of the class Turbellaria that contain a nervous system and spinal cord that are ideal for drug withdrawal research and addictive substance research (British and Temple University). Which led to the purpose of this project, being to see the effects of addictive substances on mobility and relate that back to humans. If planaria show withdrawal and decreased mobility, it means humans will likely show symptoms too.

This diagram represents the planaria nervous system compared to a human’s. The planaria nervous system is almost like a human’s which allows this experiment to connect to humans and the real world.

Hypothesis
In this experiment the null hypothesis would be that addictive substances have virtually no effect on the mobility rate of planaria. The alternative hypothesis however would be that the addictive substances will lower the velocity of the planaria and constant exposure may cause a tolerance within the planaria.

Methodology
I had to separate the planaria into their own jars and label them. The planaria are also fed once a week with egg yolk.

Materials
The most important materials for this project are as follows:
- 75-78mm planaria
- 1 petri dish
- 1 sheet of 5cm grid paper
- 2 gallons of spring water
- 3 well plates
- 1 vernier caliper
- 1 egg yolk every week
- 1 egg yolk
- 500mL-10% nicotine solution
- 500mL-10% caffeine solution

Results
This is the where the planaria live. They need to be fed once a week and have their water changed every other day.

This graph shows the results over the course of the 7 different exposures. These are the changes in velocity average over time.

<table>
<thead>
<tr>
<th>Average Velocity</th>
<th>Water</th>
<th>Nicotine</th>
<th>Caffeine</th>
<th>Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>100mm/s</td>
<td>70mm/s</td>
<td>60mm/s</td>
<td>50mm/s</td>
<td>40mm/s</td>
</tr>
</tbody>
</table>

This data table shows the average velocities of the planaria in different substances over the different exposures. The changes in velocity can be seen over time along with the standard deviations.

Conclusion
The hypotheses stated that the exposure to these addictive substances will cause the planaria’s velocity to lower and may cause tolerance within the planaria. Through this experiment, it can be found that the exposure did lead to a decreased mobility in the planaria and looking at the sugar solution, it seems that a tolerance was building up. Looking at the graph, it shows that the velocities of these exposed to caffeine and nicotine steadily decrease over time, whereas the sugar drops then comes back up. This seems to show that sugar did not have much of an effect on the planaria as once thought. Also looking at the standard deviation for the sugar, it is very low at 0.00959516782. This means that the numbers do not differ from the mean much and that the sugar did not have much of an effect.

Analysis
In this experiment it seems as though nicotine and caffeine show a constant decrease in the velocity of the planaria, whereas the sugar showed the opposite. The planaria had a tolerance to the sugar and the velocity came back up. It is assumed that nicotine and caffeine are harder for sugar to accumulate a tolerance to when compared to sugar. The nicotine and caffeine however could also just simply be stronger than the sugar and that is what caused sugar to come back up. There could be an error in how the measurement method as human error can always occur in situations like these. A simple error such as a typo or tracking the wrong planaria could have an effect on this experiment and the statistical significance of the data, the standard deviation of each solution velocity was found. The standard deviations are as follows: water with 0.003176176176176176, nicotine with 0.00959516782, caffeine with 0.0011098194086, and sugar with 0.00959516782. This means that the water had little to no difference in data, which should be the case as it was the control. The nicotine and caffeine however did have a change as the exposures increased meaning there was more tolerance in the data showing there was an effect on the velocity. The sugar also had a lower standard deviation which shows the planaria acquiesced a tolerance to the sugar and were becoming used to it, meaning the planaria can tolerate sugar more than the nicotine and caffeine.

Acknowledgements
I would like to thank Mr. Steckler as my STEM course teacher for providing input whenever needed. I would also like to thank Mrs. Avena Calm (US Army Reserve) for being my mentor and providing resources to use that helped the experimental process. I would also like to thank Charles Teague for helping with the experiment process as well by helping with the long and tedious parts of the experiment.

Citations
Title Optimizing Drone Propellers Using 3D Printing Technology

Summary
The purpose of this project was to figure out if I could improve upon the original propellers of a drone by changing the shape of custom made propellers, using a 3d printer to create them.

To do this, many different propellers were modeled and printed in the same filament, then test them by measuring how much mass they could lift on a scale. If they had little to no improvement compared to the stock propellers, it would support the null hypothesis, whereas it would support the alternative hypothesis if they created a significant amount of force. After collecting all the data, the propellers would be reattached to the drone and tested for maneuverability to figure out if the propellers work properly with the drone. Otherwise, there would be no point in printing the propellers if they do allow the drone to fly.
Optimizing Drone Propellers
Using 3D Printing Technology

By: Logan Brewer
Rising Sun High School

Abstract

The purpose of this project was to figure out if I could improve upon the original propellers of a drone by changing the shape of custom-made propellers, using a 3D printer to create them. To this end, many different propellers were modeled and printed in the same filament, then tested by measuring how much more they could lift on a scale. If they had little or no improvement compared to the stock propellers, it would support the null hypothesis, whereas it would support the alternative hypothesis if they created a significant amount of force. After collecting all the data, the propellers would be ranked from the strongest to weakest for manufacturability in such a way if the propellers work properly with the drone. Otherwise, there would be a need for changing the printing settings if they do not allow the drone to fly.

Introduction

This project examined whether a 3D-printed propeller would perform better than the stock propellers. Youther, RC1060, is a small round propeller, often used in RC aircraft models and small drones. This propeller is relatively simple in design and is known for its durability. The purpose of this project was to test the hypothesis that a 3D-printed propeller would perform better than the stock propeller.

Materials and Methodology

1. Propellers are modeled and printed in sets of four, then cleaned from any support material or loose strands.
2. They are fitted onto motor mounts and the mass is recorded for calculations.
3. The motors are turned on, and the power is increased in increments of 25%, starting at 100%. The amount of force is recorded at each interval.
4. Force is calculated by using the initial and final thrust output, and is repeated for the next three propellers. Using a constant process keeps and everything organized.
5. It’s important to print the propellers consistently as possible, so that the propellers don’t vary from each other. However, if the propellers are not printed consistently, it is the only way to get the best possible results.

Results

After the 20% pitch, the propellers begin to stall & create less thrust.

Tapered Propellers

Twisted propellers may hindered its performance at such a low diameter and speed.

Conclusion

The purpose of these experiments was to test whether or not it was possible, or even viable, to 3D print drone propellers. I had originally predicted that the performance of the propellers would be equal to or better than the original propellers, but after testing a variety of propellers, I was able to conclude that printing the propellers had little to no benefit over the stock propellers, so the project would more closely support the null hypothesis.

However, the hypothesis cannot be entirely ruled out. I previously stated that one can reason that the props created such little thrust was due to the print settings. Since the amount of work the motors had to do to the blades, this waste energy ended up being a huge disadvantage to the printed propellers. If they had been made lighter or smaller, would have likely produced more thrust. The reason for this propellers were printed was because there was not enough time to produce and test them.

Citations

- Youtube. (2019). 3D Printed Drone Propellers - Will it Work? [Online Available]. Available at: https://www.youtube.com/watch?v=2k5Fz9kEBk0.
- Ferris, J. (2009). Drone propellers how to fly the science of flight. [Online] [Dovey Rusch]. Available at: https://www.youtube.com/watch?v=2k5Fz9kEBk0.

Acknowledgements

I would like to acknowledge the following people for helping with my project and making it possible:
- George Jacobson, Aeronautical Engineer A&P. AIAA, Airframe and Powerplant
- Mrs. Shirley Wilke RSHS Robotics Teacher Mentor
- Michael Knezevic for designing a drone for project
- AIAA and ARMY AIDP for materials and equipment
- Mr. Stacker teacher Capstone Teacher
Summary
A player's shoe can have a big role in their performance during his/her game or match. Sports like basketball, tennis, volleyball, and wrestling require quick movements in side to side directions.

A shoe with low friction can be harmful to a player's performance and safety. In this experiment, shoe sole tread pattern will be tested to calculate the coefficient of friction. In order to do this, the equation for Static Friction \( (f_s=\mu_s F_N) \) will be used to calculate the coefficients of static friction after finding the forces of Static Friction using the Dual-Range Force Sensor.

Null hypothesis- Tread pattern will have no impact on the coefficient of friction created.

Alternative Hypothesis- The tread pattern with the most horizontal tread will have the highest coefficient of friction.
How Outsole Material and Tread Pattern Affect the Coefficient of Static Friction

Avery Brooks
Rising Sun High School

Abstract Hypothesis

A players shoe can have a big role in that players performance during either game or match. Sports like basketball, tennis, volleyball, and wrestling require planting one’s feet to side directions. A shoe with low friction can be harmful to a players performance and safety. In this experiment shoe sole tread pattern will be tested and the friction will be measured in regards to the angle. The friction is defined as the ratio of a force that acts opposite of motion. The purpose of this experiment is to determine the effect of the outsole material and the tread pattern on the coefficient of static friction. The hypothesis is that the coefficient of friction will vary depending on the material and tread pattern.

Introduction

In this experiment the coefficient of both static and kinetic friction will be found for different materials and different and pattern treads on shoes. The coefficient of friction is the ratio between the frictional force and the normal force. This is the force that is exerted on the object by the surface that it is on. The larger the normal force the larger the frictional force. The materials and tread patterns will be varied in order to see the effect on the coefficient of friction.

Methodology

1. Connect the Dual-Range Force Sensor to Channel 1 of the interface. Set the range switch on the Force Sensor to 50 N.
2. Graph should be measuring Force vs Time. (Force is y-value, Time is x-value)
3. Make graph show y values 0-5 N
4. Record weight of each sole
5. Add 2 kg weight to each sole
6. Seque sole to sole
7. Hold the Force Sensor in position
8. Click to set the Force Sensor to zero.
9. Click collect to begin exit testing data. Slowly and gently pull horizontally with a small force. Very gradually, taking one full second, increase the force until the sole starts to slide, and then keep the block moving at a constant speed for another second.
10. Repeat the process as needed until you have a graph that reflects the desired motion including pulling the area at constant speed once it begins moving.
11. Highlight area of graph that show peak static friction and use “Statistics” button to record the maximum value.
12. Repeat this 10 times for each sole in order to get accurate results.
13. Use the equation \( f = \frac{F}{N} \) to calculate the coefficient of static friction and \( f = \frac{F}{N} \) to calculate the coefficient of kinetic friction. The Force of friction is equal to the applied force and the Normal force is equal to the force of gravity on the object.

Results

<table>
<thead>
<tr>
<th>Tread Pattern</th>
<th>Mass (kg)</th>
<th>Normal Force (N)</th>
<th>Peak Static Friction (N)</th>
<th>Coefficient of Friction</th>
<th>Surface Area cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeatability</td>
<td>2.206</td>
<td>22.345</td>
<td>16.54</td>
<td>0.76904</td>
<td>250</td>
</tr>
<tr>
<td>Zig zag</td>
<td>2.406</td>
<td>24.011</td>
<td>18.142</td>
<td>0.75644</td>
<td>275.6</td>
</tr>
<tr>
<td>Small circles</td>
<td>2.412</td>
<td>23.043</td>
<td>13.252</td>
<td>0.59068</td>
<td>300</td>
</tr>
<tr>
<td>Diamond</td>
<td>2.434</td>
<td>23.855</td>
<td>10.885</td>
<td>0.45623</td>
<td>310</td>
</tr>
</tbody>
</table>

Shoe being pulled by Vernier force sensor

Friction is a force that acts opposite of motion. Athletes want a shoe that creates the most friction so they can make quick movements without slipping and sliding across the floor.

By using the Vernier force sensor, the static coefficient for each shoe tread was able to be found. Ten trials were performed on each type of tread and the average was calculated. The shoe tread that created the greatest coefficient of friction was the zig zag tread pattern with a gel like material. It had a coefficient of friction of .7554. This was very different from the diamond tread pattern with very hard rigid material having a coefficient of friction only being .4556.

Conclusion

The results gathered from this experiment support my alternative hypothesis. The data showed the zig zag tread pattern had the highest coefficient of friction. Even though this sole had the largest surface area it still managed to produce the highest coefficient of friction. An alternative hypothesis stated that the tread pattern with the most horizontal direction would have the greatest coefficient of friction. Having a zig zag pattern this tread is going both vertical and horizontal making best use of the space on those shoe.

Having a horizontal tread pattern, this tread was able to create more grip and contact to the board. This created more frictional material, which resisted the motion of the shoe being pulled. Using a zig zag tread would be best for a real game scenario considering an athlete would not only be moving forward and backwards but also side to side. requiring quick stops and changes of movement from all directions. This specific tread grooves were made deeper than the rest of the other treads used making the gel like material to be able to grip to the floor stopping the shoe and resisting motion instead of being pulled along with the initial movement than the rest of the shoe worn. Using a zig zag pattern tread with a soft gel material as a boot for an indoor sport like basketball. It would allow the players to stop quickly from movements in any direction and the soft bottoms would prevent slipping and promote greater grip to the floor allowing for quick movements.

Acknowledgements/ Sources

I would like to thank Mr. Stoder for helping me throughout my whole project and its process.

Title  Pocket Stand

Problem Statement
There have been over 300 million downloads for YouCam Perfect in the world in the past 5 years. This app allows for better quality photographs. Additionally there are multitudes of different attachments for phones for photography purposes such as attachable camera lenses and tripods, proving that consumers are willing to find a new way to capture better quality photos using their cell phone.

Solution
We decided on the Pocket Stand. It attaches to the back of the phone with double sided adhesive tape. It uses an aluminum rod as an axel and allows for horizontal, vertical and diagonal positions with your phone.
Pocket Stand
Honors Engineering Design and Development, Rising Sun High School
By: Tyler Brown, Josh Moskes, Stuart Kotch

Viability of a problem
We found that we had a good target audience to which we could market this problem. We decided that Rising Sun High School students and staff members would be the population we would conduct our research on. We then, created a google survey with questions that would tell us if our problem was valid and necessary. We found that 80.8% of the students liked taking pictures on their phone. We also found out that students would pay between $11 and $20 too improve their photo taking abilities. We predicted that we could inexpensively create a solution that would increase a mobile devices ability to take a photograph.

Prototyping phase
We decided to pursue a combination of our two initial ideas, thus allowing for handless horizontal and vertical standing.

Analysis
Even though the drop test or the temperature test where not completed, Stuart used the pocket stand daily for around 3 months and has found only two problems that would of been fixed with more time. Those being water can undo the double sided adhesive and the loosing of the flip overtime yet this does no real harm to the purpose of the project.

Initial Ideas
1. A tripod that flips out from your phone too hold it up
2. Blocks that were attached to a phone to give flat edges balance on

Testing
Limited testing due to vivid-19. One idea we didn’t get to test involving strength of the phone stand was putting it on a phone shaped wood block that also weighed similar to a phone and dropping it, seeing how often or if it would break at all.

Conclusion
We wish we could have had more time together to really clean up the idea or even add on to the idea but what we left off with was a good prototype that is useable.

Solution
We decided on the Pocket Stand. It attaches to the back of the phone with double sided adhesive tape. It uses an aluminum rod as an axel and allows for horizontal, vertical and diagonal positions with your phone.

Problem Statement
There have been over 300 million downloads for YouCam Perfect in the world in the past 5 years, this app allows for better quality photographs. Additionally there are multitudes of different attachments for phones for photography purposes such as attachable camera lenses and tripods, proving that consumers are willing to find a new way to capture better quality photos using their cell phone.
Title  Effectiveness of Cleaners on Wrestling Mats

Summary
To test the effectiveness of the school’s cleaner, wrestling mats will be swabbed and plated onto nutrient agar where bacteria will grow and can be used to determine the effectiveness of the cleaners, seeing if the wrestling mats are a potential source of infection at school. The mats will be swabbed before and after cleaning, transferred to nutrient agar petri dishes, incubated, CFU counted and put into an equation to produce the final effectiveness.

In the end, it is concluded that at a 1% and 100% dilution the most effective cleaner is KenClean with 42.93% killed and 85.64% respectively.
Effectiveness of Cleaners on Wrestling Mats

Eva Cook

CCPS STEM Academy at Rising Sun High School

Abstract

The school mats are routinely cleaned and stored in the auxiliary gym to test the effectiveness of the school’s cleaner, wrestling mats will be swabbed and plated onto nutrient agar where bacteria will grow and can be used to determine effectiveness. The purpose of this project is to determine if wrestling mats are a true source of illness. School mats are used often and usually are only cleaned during the seasons on which athletes use them. Because of the conditions of the storage and use of the mats, the possibility that school mats are a source of illness. According to Children’s Hospital of Colorado’s Matthew Bremer (MS, ATC, Athletic Trainer, Sports Medicine for Young Athletes, Children’s Hospital Colorado) “bacteria and viruses thrive in hot, moist and dark enclosed environments” which is exactly where the mats are stored at Rising Sun, and without the aid of effective cleaners, bacteria could spread and multiply in abundance.

This is a ringworm infection. The tell-tale sign of a ringworm infection is the dark circles or red pattern around a lighter inside. They also tend to be scaly and can be itchy. Ringworm is commonly associated with wrestling athletes.

Introduction

There are multiple illnesses and skin diseases that are associated with wrestling and or floor related activities such as using wrestling mats. The purpose of the project is to determine if wrestling mats are truly a source of illness. School mats are used often and usually are only cleaned during the seasons on which athletes use them. Because of the conditions of the storage and use of the mats, the possibility that school mats are a source of illness. According to Children’s Hospital of Colorado’s Matthew Bremer (MS, ATC, Athletic Trainer, Sports Medicine for Young Athletes, Children’s Hospital Colorado) “bacteria and viruses thrive in hot, moist and dark enclosed environments” which is exactly where the mats are stored at Rising Sun, and without the aid of effective cleaners, bacteria could spread and multiply in abundance.

Materials

Nutrient agar, nutrient broth, 500 ml beaker, water, bioburden trash bins, weight, brush, scale, spatula, caliper, microwaves, petri dishes, plastic wrap, graduated cylinder, incubator, disinfectant wipes, gloves, hot glue gun, scissors, small squares of wrestling mats, E. Coli in a vial, Sanicloth in a small vial, and glass vials.

Disinfectant Cleaner distributed at 100%, 10%, and 1% (

C. loriux liquid at 100%, 10%, and 1%, SaniCloth liquid at 100%, 10%, and 1%, E. coli plates, disinfection wipes, sponges, and sanitizer."

KleenClean Plus

Cleaner used on school mats.

Sanicloth wipes

Prep used on equipment.

Methodology

**PROCEDURE ONE:**

Use moist cotton tipped swabs to collect bacteria off the wrestling mats. This will be done before and after the cleaning of the mats to gauge how effective the cleaner is on killing the bacteria on the school’s wrestling mats. Using the swabs, transfer the bacteria onto an agar plate. Place these petri dishes in an incubator for 24 hours to give the bacteria time to grow and present on the plates. Count the number of colonies of bacteria and count in data tables, being sure to take pictures for later reference. To determine an effectiveness, the CFU count after was divided by the count, this gives a decimal. Then subtract the decimal from one and multiply by one hundred, this gives the percentage of bacteria killed. This percentage will correlate to the effectiveness of the cleaner. Repeat the procedure as the wrestling season progresses.

**PROCEDURE TWO:**

Coli-great swabs of wrestling mat pieces about 1.31cm that are cut glad into the bottom of a Petri dish for ease of handling. As the primary cleaner, to completely clean the mats, they were swabbed with brush using sterile cotton swabs to make sure all areas were swabbed and plated to guarantee cleanliness. Using a sterile inoculating loop, an E. coli broth was made and inoculated for two hours using cotton swabs that E. Coli is plated on the wrestling mats swabbed and incubated for 48 hours. After waiting the 48 hours,swabbed and counted. This gives you the initial CFU count. Following this, clean the mats with their respective cleaners, two pieces of mat for each cleaner solution. Let the mats air dry. (This is how the procedure of cleaning at Rising Sun is done), then take swabs and plate these. This is your final count. Let all the plates incubate together, as is necessary to compare cleaning solutions. Take pictures for reference (just in case). Using the before and after CFU counts, we determine if the final count divided by initial count gives a fraction which when subtracted from one and multiplied by 100 gives a percentage of bacteria killed. This then correlates to an effectiveness.

Results

1. **Initial CFU Count:**

   - Sanicloth 100% 154
   - KleenClean Plus 10% 20
   - KleenClean Plus 1% 2

2. **Final CFU Count:**

   - Sanicloth 100% 15
   - KleenClean Plus 10% 2
   - KleenClean Plus 1% 1

   **Percentage Killed:**

   - Sanicloth 100% 94%
   - KleenClean Plus 10% 95%
   - KleenClean Plus 1% 99%

Conclusions

It is concluded that KleenClean cleaner is the most effective cleaner with KleenClean at a one percent dilution had an average percentage killed of 94.92%, at the 10% dilution there was a percentage kill of 91.79% and the 100% dilution had an 85.64% kill. The auxiliary gym 1% dilution killed 18.26% of bacteria, the 10% dilution killed 30.35%, and the 100% dilution killed 41% of the coli. The Cloorix 1% one percent dilution of 19.93% killed the 1% dilution had 29.75% killed and finally the 100% dilution had 21.16% killed. These results are only obtained within the brief duration of the cleaning process. Using the best and worst cleaners where KleenClean is the most effective and Cloorix wipes fall into the latter category. This is not to say that the chore wipes are completely ineffective, this could just be an instance where the chemicals in the wipes are not as strong as the chemicals in the other two disinfectants. For example, the KleenClean sample is filled with chemicals that are dangerous to human skin if they are exposed, whereas the Cloorix wipes are used with the 100% dilution on all equipment. Moving on or expanding the results of this experiment could include finding other cleansers and testing them to see, overall, what the most effective cleaner is.

Acknowledgments

- Mrs. Alena Calm Biologist, US Army Edgewood Chemical and Biological Center, for mentoring my project
- Mr. Daniel Moore, gym teacher, for allowing me to use extra school mats to cut up and use
- Greg Stidlick for helping feed field, set up, and carry out my project

Sources

- HARRIET E. HANIEIR, M.D., Medical University of South Carolina, Charleston, South Carolina Am Fam Physician, 2003 Jan 16;77(3):181-199
- http://biotech.doe.gov/docid/1082-1062-550-52.1.02
Title  Comparing the Biodegradability and Strength of Bioplastics to Petroleum Based Plastics

Summary
The purpose of this project is to see if bioplastics can be more durable and more degradable than petroleum based plastics.

The null hypothesis is if a bioplastic is made out of plant based material, then there will be no difference in strength or decomposition with petroleum based plastics.

The alternative hypothesis is if a bioplastic is made out of plant based material, then there will be a significant difference in the decomposition rate, with a similar strength.
Comparing the Biodegradability and Strength of Bioplastics to Petroleum Based Plastics.
Bryson Crowl
STEM Academy, Rising Sun High School, North East, Maryland

Abstract

The purpose of this project is to see if bioplastics can be more durable and more degradable than petroleum based plastics. I selected this topic because I plan to have a job in the future that has some sort of chemistry in it, probably a chemical engineer (not my final job choice). I chose this particular aspect of chemistry to find out the best way to reduce plastic pollution in the Earth. The null hypothesis for this project is that a bioplastic is made out of plant based material, then there will be only one difference in strength and decomposition with petroleum based plastics, whereas there would be no need for bioplastics. The alternative hypothesis is if a bioplastic is made out of plant based material, then there would be a very close similarity in the strength and significant difference in the decomposition rate, so that bioplastics would be a better fit than petroleum plastics due to their eco-friendly qualities. According to the website matweb.com and creativemachinery.com, the tensile strength of acrylic plastics is 70 MPa and PLA (chemical for bioplastics) has a tensile strength of 60 MPa.

Methodology

- Peel 2 type of plant starch into the beaker
- Add 50 ml of water
- Add 5 drops of glycerin
- Stir until no chunks are present (food dye if desired)
- Heat in microwave until it starts to boil, a little less than 10 seconds
- Stir again, then pour into mold, and let sit for a couple of days
- After making roughly 32 of these samples, do 2 tests of 8 trials each
- One set of tests will be degradation. For this, put a piece of that plastic into each of the different environments (moist, soil, water, air)
- After 3 weeks, record the amount of mass that was lost. The other test will be durability, in which 5 of the pieces will be tested to see how many Newtons it takes for it to break.

Results

The results are very simple for this project, and are very clear to see. It was found that Potato starch plastic was the strongest out of the Bioplastics, and corn starch plastic was the weakest. A surprise in this project was a traditional plastic, polyethylene, was weaker than both the potato starch and tapioca starch plastics. This could be the fact that the polyethylene plastic was thinner than the other plastics, probably making it easier to break. The standard deviation of all the plastics that broke (not including acrylic) was 18.48. It was also found that each of the plastics lost more or less the same amount of mass. The potato starch plastic lost the most while sitting in the air. The tapioca starch plastic lost the most in moist soil. Acrylic plastic proved to have the least degradation rate with polyurethane behind it. In the three weeks, the two traditional plastics actually gained mass in the wetter environments. This is probably due to the growth of mold, or they possibly could’ve still had water mass.

Plastics tested

<table>
<thead>
<tr>
<th>Break Point (Newtons)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>AVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corncob Starch</td>
<td>45.97</td>
<td>77.14</td>
<td>25.35</td>
<td>72.51</td>
<td>15.57</td>
<td>22.24</td>
<td>53.38</td>
<td>37.84</td>
<td>41.48</td>
</tr>
<tr>
<td>Potato Starch</td>
<td>40.03</td>
<td>40.03</td>
<td>62.28</td>
<td>78.73</td>
<td>56.71</td>
<td>80.07</td>
<td>95.64</td>
<td>71.17</td>
<td>64.48</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>86.52</td>
<td>93.36</td>
<td>95.45</td>
<td>64.45</td>
<td>186.03</td>
<td>173.48</td>
<td>84.93</td>
<td>80.07</td>
<td>82.87</td>
</tr>
<tr>
<td>Acrylic</td>
<td>&gt;300</td>
<td>&gt;300</td>
<td>&gt;300</td>
<td>&gt;300</td>
<td>&gt;300</td>
<td>&gt;300</td>
<td>&gt;300</td>
<td>&gt;300</td>
<td>&gt;300</td>
</tr>
</tbody>
</table>

Plastics tested

These are samples of all three bioplastics, and the control variables, polyurethane and acrylic plastic.

Citations

- Sharma, V. (2018). Are there ways of developing eco-friendly plastic?

Acknowledgements

I would first like to thank Mr. Sticker, the capstone teacher at Rising Sun High School, for helping me when I needed assistance. And for supplying me with some ingredients, I would also like to thank Mrs. Davis & Professors for obtaining articles about my project that I can look to for a better understanding of this project. Lastly, and most important I thank Dr. Julia Claisse, the Research Aerospace Engineer and Materials Science from NASA, for giving me great insight and ideas for my project and being willing to be my mentor.
Title The Effect of Grain Orientation and Lay-up Pressure on the Ultimate Breaking Force of Plywood

Summary
The purpose of this project was to determine if changing factors of the manufacturing process would also change the strength of the plywood produced. Plywood is manufactured through layering several veneer sheets at a right angle to the previous layer. My data revealed that alternating grain orientation has the ability to resist warping and hold a strong maximum breaking force. The pressure during the vacuum press process was also tested. It was expected per Gorleski’s research, “

Setting the system to pull higher vacuum levels does not improve the bond of the veneer to the substrate. This project produced opposing data. This project has inspired me to continue studying Material Science in college.
The Effect of Grain Orientation and Lay-up Pressure on the Ultimate Breaking Force of Plywood

Thomas Dymowski, CCPS STEM Academy, Rising Sun High School
Mentor: Dr. Denise Yin

Abstract

The purpose of this project was to determine if changing factors of the manufacturing process would also change the strength of the plywood produced. Plywood is manufactured through layering several veneer sheets at a right angle to the previous layer. My data revealed that alternating grain orientation has the ability to resist warping and hold a strong maximum breaking force. The pressure during the vacuum press process was also tested. It was expected per Gorleski’s research, “...Setting the system to pull higher vacuum levels does not improve the bond of the veneer to the substrate.” This project produced opposing data. This project has inspired me to continue studying Material Science in college.

Introduction

Materials science is the study of certain materials and their physical and molecular properties. This project tested the physical properties of plywood, specifically the grain orientation of each layer and the pressure during the vacuum press process. A main theory about plywood is that the strength comes from the amount of layers present. “Plywood strength drops when thickness diminishes.” (Shaddy). Unfortunately, this variable was unable to be tested due to the Covid-19 outbreak. The grain orientation does affect the strength of plywood. Wood is made of many cellulose. The cellulose are seen as the grain of the wood. “Cellulose is the strongest polymer in wood and, thus, is highly responsible for strength...” (Winandy). When the orientation of these fibers change, there is a change in the strength of the wood.

The vacuum press system that was used was the Excel 1 vacuum pump. This pump allowed for many different pressures ranging from 3 In Hg to 25 In Hg. Pressure would affect the consistency of the bond, and the amount of air left in the sample. Veneering expert, Joe Gorleski, suggested a pressure of 21 In Hg. This pressure worked to keep no air pockets, and delivered a tight bond.

Methodology

Means glue powder Measure water Mix powder, water Stir the mixture Lay out the veneers Apply the glue evenly Press the veneers together Place the layers in the vacuum bag Set the pressure to 21 In Hg and let it press for 1 hour

Results

This graph shows the comparison of the maximum breaking force for each grain orientation. It is seen that the force increases as the amount of layer resisting the applied force increases.

The grain orientation did have the hypothesized effect on the ultimate breaking force of the plywood. The grain orientation did have the hypothesized effect. From the research that I conducted, pressure should not have increased as much as it did after 21 In Hg. I believed that the strength would decrease as the pressure decreased, because it would hold a weaker bond. But at a pressure of 21 In Hg, the force should have been the largest it could. All plywood should be made with a higher pressure to increase the ultimate breaking force.

Conclusion


Acknowledgements

Dr. Denise Yin for being my mentor through this project and helping me to think like a materials scientist.

Greg Stickler for being my Capstone teacher and helping me to think through my ideas.

Joe Gorleski for giving expert advice about the materials to use and the vacuum press system.
Title  How Temperature Impacts the Bacterial Growth and Nitrate

Summary
Fish tanks go through what is called the nitrogen cycle, which explains that every time fish eat, they produce waste that contains ammonia which is converted to nitrite finally converted to nitrate. The completion of this cycle is essential for the survival of the fish, as ammonia is toxic to them.

This project will be using two tanks to raise trout based upon the Trout in the Classroom Program of Maryland Department of Natural Resources.

Measurements of the amount of bacteria as well as the nitrate levels will be compared between the two tanks to see how temperature has an impact on them. Both tanks will be set up the exact same and water chemistry tests will be performed daily to maintain the conditions of both tanks and to eliminate differences in the tank caused by outside factors.
How Temperature Impacts the Bacterial Growth and Nitrate Concentrations in Oncorhynchus mykiss Tanks

Katie Gibson
CCPS Stem Academy

Introduction

There are many concerns with the environments of Oncorhynchus mykiss hold-water streams in areas in Maryland, especially since water where fish are can be released into water through irrigation runoff, irrigation water, and bacterial growth. A great protection of the health of organisms in these streams. Although habitats occur naturally in soil and water, it may be necessary to control conditions to a Schramm's of ground and surface waters. Most sources of excess nutrients come from nutrication in agriculture and their improvement Groups. Ammonium is converted into nitrate which is then nitrified into nitrite by bacteria. Nitrogen ammonium and water levels prevent fish from absorbing oxygen through their gills, which often die, making effective use of the gas and a brown color, nitrates will be seen at the surface before any concentrating stream. The 46th Annual MDNR, 2017. Nitrate is critical for the health of fish that contain nitrate. Trout Unlimited expressed an interest in how water temperature impacts bacteria growth, which will impact how much nitrate is created, consequently impacting the development of the trout.

Hypotheses

It is hypothesized that a change in temperature will not cause a significant change in the bacterial growth and nitrate levels in the tanks. It is hypothesized that a change in temperature will cause a significant change in the bacterial growth and nitrate levels in the tanks.

Methodology

Two 55-gallon tanks will be set up in the classroom, each with insulation covering all sides. The filter and chiller will be hooked up and running before the fish arrive. Digital thermometers will be set up to closely monitor the temperature of both tanks and keep them consistent. The breeder box will be set up as well in order to provide the fish with fish food. The tank should be prepared to provide for the fish and to ensure that fish are not caught in any of the equipment. Dead fish will be removed. The amount of food given to the fish will also be measured to keep it consistent in both tanks.

In addition, the quality of the water will be tested daily. The pH of both tanks will be measured using both test solutions and a pH sensor. The ammonia levels of both tanks will be measured using test solutions. The nitrite levels or both tanks will be measured using test solutions and a nitrate ion-selective electrode. For the measurements made using test solutions, 5 ml of tank water will be put into a test tube and a certain amount of drops will be placed into the test tube, shaken, and 5 minutes later, the color of the solution in the test tube will be matched using a key that corresponds to a measurement.

A separate mini experiment was conducted to test the nitration of bacteria at different temperatures. 1300 ml of water was placed in a bottle and 1 ml of ammonium was added to get a reading of 4 ppm. These were then placed in different bottles where three were placed at room temperature and three in the fridge. After a few days, the water quality was tested using the test kits mentioned previously in order to compare the activity of the nitrifying bacteria.

Data Analysis

The test solutions being used to test the water quality along with their color keys.

Conclusions

It was not discovered whether there was a significant difference in bacterial growth or bacterial activity between the two tanks. The side experiment was conducted to provide an answer to that question in a more controlled setting. But the results were not as expected due to the side effects. After doing a 2 Sample T Test for a difference in population means, the p-value 0.007 was produced, indicating statistically significant evidence that there was a difference in the nitrate levels of the two tanks. The hypothesis that the nitrate levels were different in the tanks at different temperatures was supported.

References

Use the National Institute of Health, 2014. How to Raise Trout in Maryland Classrooms.


Acknowledgements

Thank you to Mr. Gregg Salser for guiding this project every step of the way and providing advice consistently.
Thank you to Tom Giammarino for being the mentor for this project and guiding us through the processes of setting up the tanks and understanding the data that was collected.
Thank you to Chuck Oinkel and Trout Unlimited for providing a tank set up and coming up with an idea of what to study with the trout.
Thank you to the Maryland DNRC for giving us a grant for our other tank setup.
Noah Jones
Grade 11
Rising Sun High School

Title
Analyzing how Common Coverings affect Mass and Forensic Decomposition of the Body

Summary
This project investigates the effect coverings have on the decomposition process of the body.

In a study by S. C. Voss, a raw pig carcass was used in replacement of a human body because “The domestic pig is the internationally recognized animal model for human decomposition.” Pig parts will be used in this investigation to most accurately reflect the outcomes the human body would portray. In order to apply a better understanding of forensic decomposition and to measure time of death in a real life situation we will control coverings and “manner of burial” of each part.
Analyzing how Common Coverings affect Mass and Forensic Decomposition of the Body

Noah Jones CCPS STEM Academy Rising Sun High School

Abstract

This project investigates the effect coverings have on the decomposition process of the body. In the lab, 5 C. elegans nematodes were placed in a replacement of a human body because “the nematode is the internationally recognized model for decomposition.” They were then covered by ‘food grade’ ‘plastic bag’ or a human body. The nematodes were then placed in a Petri dish to see how long it took for their bodies to be decomposed. The results showed that the nematodes without coverings took longer to decompose than those covered. This showed that coverings help to speed up the decomposition process.

Methodology

1. Cover the C. elegans nematodes with plastic bags.
2. Place the C. elegans nematodes in a Petri dish filled with nutrient agar.
3. Record the number of nematodes in the Petri dish.
4. Observe the nematodes for 10 days.
5. Record the number of nematodes in the Petri dish daily.

Results

The results showed that the nematodes without coverings took longer to decompose than those covered. This showed that coverings help to speed up the decomposition process.

Conclusion/Analysis and Discussion

During the investigation, mass was recorded once a week for eight weeks. This was then correlated into a table and after the data was collected, the average mass loss was calculated. The average mass loss was calculated by subtracting the final mass from the initial mass. The final mass was then divided by the initial mass and multiplied by 100 to get the percent mass loss. The results showed that the mass loss was significantly higher in the uncovered condition compared to the covered condition. This supports the hypothesis that coverings help to speed up the decomposition process.

Acknowledgements

I would like to thank my forensic science and microanalyzer for guiding me in my project and helping me with the project. I would also like to thank Mr. Stolper for guiding me through the entire year and looking over every aspect of the project. I would also like to thank Mrs. Dey for being my editor and helping me along the way.

Sources:


Promos: STUDENT STORY POST TO Learn ABOUT DECOMPOSITION RATES OF HUMAN REMAINS (2005, Nov 06).
Title  Teacher Academy of Maryland  
My Next Chapter of Teaching

Summary
Student will be able to complete a rigorous, college-level program that is based on the outcomes of the Maryland Associate of Arts in Teaching (A.A.T) degree, which aligns with the National Council for the Accreditation for Teacher Education (NCATE) standards by exploring Human Growth and Development, Teaching as a Profession, Foundations of Curriculum and Instruction and participating in an Education Academy Internship in a CCPS school.
Teacher Academy of Maryland  
Jordyn Keys Grade 12 RSHS  

RISING SUN HIGH SCHOOL  
Cecil County School of Technology  
Class of 2020

Topic: My Next Chapter of Teaching

Outcome / Objective:
SWBAT (Student will be able to) complete a rigorous, college-level program that is based on the outcomes of the Maryland Association of Arts in Teaching (AA.T) degree, which aligns with the National Council for the Accreditation for Teacher Education (NCATE) standards by exploring Human Growth and Development, Teaching as a Profession, Foundations of Curriculum and Instruction and participating in an Education Academy Internship in a CCPS school.

Activities:
1. First Lesson - My first lesson was based on what I could teach the class. This lesson was “How to blow up a balloon using baking soda.” I wanted to teach the class how when baking soda and vinegar come together it can make a balloon blow up. This was the first lesson I had to come up with including buying all the supplies having time management and also being in control of a classroom filled with kids my age. Mrs. Eddinger put pressure on us by recording us with our first lessons, after she did that it made me be able to teach better than when I came into the classroom.

2. Baby Project - After a couple weeks of learning child development, each student was given a flour or sugar baby to take care of. As these babies came in different sizes while some were 6 pounds others were 3 and 10 pounds, this was used for the project because some babies come in all different weights. I was given a 5 pound bag of sugar. To dress our “baby” I used an outfit, diaper, a pacifier where I cut off the end to be able to put where the mouth was and I also gave the baby googly eyes. After creating the baby we were given a birth certificate to fill out, with the name of the baby, parents and date of birth. The name I chose for my baby was “Carter Nicholas Giroso.” At CSTW we were given situation cards throughout the day some of these cards included nap time, blowing noses, cudles, changing diapers and it was our responsibility as a parent to protect our baby if left alone the baby would be kidnapped and hidden until the parent realized it was gone.

3. Bulletin Board - One of our many last lessons we had to present in TAM is our Bulletin Board. Each month, each TAM student or partner set would present and create a interactive bulletin board with a short lesson that went along with it. The theme had to correspond with the month we chose. My partner and I chose the month December and created a Bulletin Board where students could display their names and birthday. We thought this was appropriate for seniors and juniors to display their birthday so we could wish them a happy birthday.

4. Internship - For the month of February we were given the opportunity to choose an Elementary, Middle or High school to interact with school aged children and to get the experience of what a teachers day consists of. I was nervous after the second visit, I knew what had to be done but I was concerned that the children wouldn’t listen to some “stranger” in the classroom. For the first couple days I made a bond with some of the kids allowing them to be able to talk to me if they needed the guidance or to even have a conversation. I had a great experience at internship and made me realize how much I enjoy kids and hope to pursue my teaching career.

Closure:
Upon my completion of the TAM program, I plan to pursue my dream and attend Cecil College in Fall of 2020 where I will be majoring in Early Childhood Education. After my two years at Cecil I plan to transfer to Towson to finish off. From being in the TAM program it has really built me in my speaking skills and learning to be okay to talk in front of people.

Assessment:
I believe that I learned how to be professional in TAM. I learned that I am a caring, helpful person and teammate who is always ready to help. When in TAM I felt as if I belonged there even if difficult situations. I also learned that it is important to use your time wisely because if not you will be stressing. I have also learned to adapt to new situations easily. Some people have different personalities when working in a group and in the end each group member must play a part for the task to be successful. When I first entered TAM I had no idea what to expect but in the end it was the best choice. Leaving the program I will be forever grateful for the people who helped me achieve such a great experience in my life.

Homework:
- Attend Cecil College to major in Early Childhood Education and apply for a job as Paraprofessional and then on to a Second Grade Teacher Future Goal – To be happy with the path I take

Acknowledgments:
- My Family - Mom, Dad, Grandparents, Siblings, Jamie Giroso and Madison Blevins
- Kelly Eddinger - Teacher Academy of Maryland Instructor, Cecil County School of Technology
- Steven Gray - Rising Sun High School Counselor and Jennifer Polski - Mentor Teacher, and Grade teacher at Rising Sun Elementary School
Stuart Kotch  
Grade 12  
Rising Sun High School

Title  Pocket Stand

Problem Statement  
There have been over 300 million downloads for YouCam Perfect in the world in the past 5 years. This app allows for better quality photographs. Additionally, there are multitudes of different attachments for phones for photography purposes such as attachable camera lenses and tripods, proving that consumers are willing to find a new way to capture better quality photos using their cell phone.

Solution  
We decided on the Pocket Stand. It attaches to the back of the phone with double-sided adhesive tape. It uses an aluminum rod as an axel and allows for horizontal, vertical and diagonal positions with your phone.
**Problem Statement**

There have been over 300 million downloads for YouCam Perfect in the world in the past 5 years, this app allows for better quality photographs. Additionally there are multitudes of different attachments for phones for photography purposes such as attachable camera lenses and tripods, proving that consumers are willing to find a new way to capture better quality photos using their cell phone.

**Solution**

We decided on the Pocket Stand. It attaches to the back of the phone with double sided adhesive tape. It uses an aluminum rod as an axle and allows for horizontal, vertical and diagonal positions with your phone.

---

**Viability of a problem**

We found that we had a good target audience to which we could market this problem. We decided that Rising Sun High School students and staff members would be the population we would conduct our research on. We then, created a google survey with questions that would tell us if our problem was valid and necessary. We found that 80.8% of the students liked taking pictures on their phone. We also found out that students would pay between $11 and $20 too improve their photo taking abilities. We predicted that we could inexpensively create a solution that would increase a mobile devices ability to take a photograph.

**Prototyping phase**

We decided to pursue a combination of our two initial ideas, thus allowing for handleless horizontal and vertical standing.

---

**Initial Ideas**

1. A tripod that flips out from your phone too hold it up
2. Blocks that were attached to a phone to give flat edges balance on

---

**Testing**

Limited testing due to vivid-19. One idea we didn’t get to test involving strength of the phone stand was putting it on a phone shaped wood block that also weighed similar to a phone and dropping it, seeing how often or if it would break at all.

---

**Analysis**

Even though the drop test or the temperature test where not completed, Stuart used the pocket stand daily for around 3 months and has found only two problems that would of been fixed with more time. Those being water can undo the double sided adhesive and the loosening of the flip overtime yet this does no real harm to the purpose of the project.

---

**Conclusion**

We wish we could have had more time together to really clean up the idea or even add on to the idea but what we left off with was a good prototype that is useable..
Title  Teacher Academy of Maryland
My Beginning Steps to Education

Summary
Student will be able to complete a rigorous, college-level program that is based on the outcomes of the Maryland Associate of Arts in Teaching (A.A.T) degree, which aligns with the National Council for the Accreditation for Teacher Education (NCATE) standards by exploring Human Growth and Development, Teaching as a Profession, Foundations of Curriculum and Instruction and participating in an Education Academy Internship in a CCPS school.
RISING      SUN      HIGH      SCHOOL

Teacher Academy of Maryland
Eden Lied

Cecil County School of Technology
Class of 2020

Topic: My Beginning Steps to Education

Outcome/Ojective:
SWRAT (Student will be able to) complete a rigorous, college-level program that is based on the outcomes of the Maryland Associate of Arts in Teaching (A.A.T) degree, which aligns with the National Council for the Accreditation for Teacher Education (NCATE) standards by exploring Human Growth and Development, Teaching as a Profession, Foundations of Curriculum and Instruction and participating in an Education Academy Internship in a CCPS school.

Activities:
1. Human Growth and Development: An important part of education is knowing and understanding the growth and development of a child. If one achieves this knowledge, the understanding of why a child is the way they are is easier and the success of a child is easier to obtain as well. There are so many factors that play into child development and human growth hence why in this program I completed multiple activities to assist and demonstrate my understanding. For example, I completed the creative development items which included a toy, a pre-social skills poster, a neck puppet show, and a game which my group made that we labeled The Race of Knowledge. With the lessons and activities that were presented and completed, I was able to obtain a more complete understanding of human growth and development.

2. Teaching as a Profession: Gaining knowledge of teaching as a profession was the vast majority of what I studied in my time in the Teacher Academy of Maryland program. There were many activities and exercises that were completed and lessons that were given in order to receive an understanding of this topic. Through these, I came to understand both the logistics and creative necessities that are to be required in order to be a successful teacher. The activities that needed to be completed got more complex as time went by allowing me to understand the topic more and more in depth. Now that I have completed my two years of the Teacher Academy of Maryland program, I have come to understand the requirements, laws, and obligations for being a teacher.

3. Foundations of Curriculum and Instruction: This was also a prominent feature of what I was required to do in my time in TAM. When referencing curriculum, the third lesson that I taught in TAM was based on a pre-kindergarten level Cecil County Public Schools curriculum assignment. The topic of my lesson was The Lion and the Mouse and the vocabulary words of angry, little, help, and happy. I created simple yet effective activities, a presentation, and a lesson plan. When putting the focus on instruction alone, I taught multiple lessons in the time I attended the Teacher Academy of Maryland program. With each lesson, I presented them in a well thought out, appropriate manner, and provided a lesson plan for each as well. The lesson that I enjoyed teaching the most was the collaborative activity lesson where I created a pirate treasure hunt in order for the students to learn the information necessary. It went over very well and it was a very successful lesson. There are many elements that go into foundations of curriculum and instruction, but I am thankful that I have an understanding of all the elements that have been presented to me so far, and I look forward to learning in the future.

4. Education Academy Internship: This experience is one that I will remember for a lifetime, and keep referencing back to throughout my future as an educator. I was placed at the elementary school that I attended upon request, Bay View Elementary School, with my mentor teacher being Mrs. Hollisier. I did face challenges in the beginning that I was not expecting. I was placed with a pre-kindergarten class and the style of teaching there was not what I was used to. Although, I changed my mindset and took on everything the experience had to offer. Helped wherever I could, and taught the three lessons that were required of me to teach in that classroom. I taught two small group lessons and one whole group and they all went very well. I learned so much throughout my time at internship, which was a total of twelve days, and gained much experience that will help me later on.

Closure:
Upon my completion of the TAM program, I plan on continuing my education in order to earn a degree in elementary education and become a teacher. I truly have enjoyed my time in the Teacher Academy of Maryland program, and I have realized that I do have a passion for education. There is no doubt in my mind that I wish to become a teacher in my future, and I do hope that I can return to Cecil County one day and become a first grade educator. I am driven and motivated to successfully complete my college degree in elementary education, and be able to get my dream job in the future.

Assessment:
I learned many important things while I was in TAM: the ins and outs of the profession, the little things that make the difference between an effective teacher and an ineffective teacher, and so much more. My knowledge has grown and I know that I will be a better educator because of it. I learned many things about myself as well. For example, I have learned where my strengths are when it comes to teaching and where my weaknesses are. I learned different ways I can handle overwhelming situations and frustrating tasks. I even learned that I would be better suited for elementary education than I would be for early childhood education. This academy was all that I had hoped for and more, and I am audacious put into action all that I have learned these past two years.

Humor:
Attend Cecil College to major in Education.
Apply for a job as an elementary school teacher in Cecil County, Maryland.
Future Goal(s): to become a successful first grade teacher, get my own house, and start a family.

Acknowledgments:
I would like to thank Mrs. Eddinger for being an amazing teacher and encouraging my drive for this profession. I would like to thank my mentor teacher, Mrs. Hollisier, for sharing her knowledge with me and helping me during my time at internship. I would also like to thank Mr. Mire and Mrs. Payne for their amazing effort at the Cecil County School of Technology and making my experience in this program possible. Finally, I would like to thank my parents for helping and encouraging me throughout this process and helping me see my talent and love for this profession.
Joshua Moskes
Grade 12
Rising Sun High School

Title  Pocket Stand

Problem Statement
There have been over 300 million downloads for YouCam Perfect in the world in the past 5 years. This app allows for better quality photographs.

Additionally there are multitudes of different attachments for phones for photography purposes such as attachable camera lenses and tripods, proving that consumers are willing to find a new way to capture better quality photos using their cell phone.

Solution
We decided on the Pocket Stand. It attaches to the back of the phone with double sided adhesive tape. It uses an aluminum rod as an axel and allows for horizontal, vertical and diagonal positions with your phone.
Pocket Stand
Honors Engineering Design and Development, Rising Sun High School
By: Tyler Brown, Josh Moskes, Stuart Kotch

Problem Statement
There have been over 300 million downloads for YouCam Perfect in the world in the past 5 years, this app allows for better quality photographs. Additionally, there are multitudes of different attachments for phones for photography purposes such as attachable camera lenses and tripods, proving that consumers are willing to find a new way to capture better quality photos using their cell phone.

Solution
We decided on the Pocket Stand. It attaches to the back of the phone with double sided adhesive tape. It uses an aluminum rod as an axle and allows for horizontal, vertical and diagonal positions with your phone.

Viability of a problem
We found that we had a good target audience to which we could market this problem. We decided that Rising Sun High School students and staff members would be the population we would conduct our research on. We then, created a google survey with questions that would tell us if our problem was valid and necessary. We found that 80.8% of the students liked taking pictures on their phone. We also found out that students would pay between $11 and $20 too improve their photo taking abilities. We predicted that we could inexpensively create a solution that would increase a mobile device’s ability to take a photograph.

Analysis
Even though the drop test or the temperature test where not completed, Stuart used the pocket stand daily for around 3 months and has found only two problems that would of been fixed with more time. Those being water can undo the double sided adhesive and the loosening of the flip overtime yet this does no real harm to the purpose of the project.

Prototyping phase
We decided to pursue a combination of our two initial ideas, thus allowing for handleless horizontal and vertical standing.

Testing
Limited testing due to vivid-19. One idea we didn’t get to test involving strength of the phone stand was putting it on a phone shaped wood block that also weighed similar to a phone and dropping it, seeing how often or if it would break at all.

Conclusion
We wish we could have had more time together to really clean up the idea or even add on to the idea but what we left off with was a good prototype that is useable.
Title  The effects of pH on Danio rerio (zebrafish) embryonic development

Summary
pH changes can have harmful effects on fish life in water, and forms of acid precipitation such as rain and snow can rapidly change the pH. A stable pH is more important than a perfect one, but most fish including zebrafish prefer a pH of around 7 to 8. A change to about 5.5 will hinder development and could kill young fish, and even lower at around 4, adult fish will start to die.

The same issues arise in very basic solutions, being less likely to survive at a pH of around 10.5 (yokogawa.com). Zebrafish take as much as a few weeks to go from very early in a development stage to being hatched, thus being an easy way to test pH changes. Significant pH changes without the fish having an opportunity to adapt puts immense stress on them, especially younger ones. Due to this, it is hypothesized that as pH decreases, the amount of fish that survive will also decrease, and the fish will develop slower.
The effects of pH on Danio rerio (zebrafish) embryonic development

Dillon Nolan
Rising Sun High School

Abstract

pH changes can have harmful effects on fish life in water, and forms of acid precipitation such as rain and snow can rapidly change the pH. A stable pH is more important than a perfect one, but most fish including zebrafish prefer a pH of around 7 to 8. A change to about 5.5 will hinder development and could kill young fish, and even lower at around 4, adult fish will start to die. The same issues arise in very basic solutions, being less likely to survive at a pH of around 10.5 (koyogawa.com). Zebrafish take as much as a few weeks to go from very early in a development stage to being hatched, thus being an easy way to test pH changes. Significant pH changes without the fish having an opportunity to adapt puts immense stress on them, especially younger ones. Due to this, it is hypothesized that as pH decreases, the amount of fish that survive will also decrease, and the fish will develop slower.

Hypotheses

The null hypothesis is that pH does not affect zebrafish embryos in any way.

The alternative hypothesis is that a decrease in pH will decrease the percent of embryos that survive, and increase the length of time it takes to hatch.

Introduction

Acid rain, as well as acid snow, can significantly alter the pH of bodies of water, resulting in the harm of many aquatic organisms. Zebrafish reproduce extremely quickly and the embryos rapidly develop in a short period of time. This combined with the low cost of maintaining them makes them a very good medium to test the effects of pH change on fish embryos (www.ncbi.nlm.nih.gov). The main topic is biology, and I selected it because working with living organisms is very interesting. The Environmental Protection Agency says that most fish eggs will not hatch at a pH lower than 5, and at any lower even adult fish can die (epa.gov). Therefore, the purpose of this project is to test the effects of pH change on zebrafish embryos and their development, a relevant question especially due to acid rain slowly becoming a more frequent occurrence.

Methodology

1. Prepare pH solution of 7, 6.5, 6, 5.5 and 4 by mixing water with sulfuric acid.
2. Transfer 3 mL of each solution to 6 petri dishes each.
3. Collect zebrafish embryos from tank gravel of a similar developmental stage, more is better.
4. Under microscope identify and transfer 1 embryo into each petri-dish.
5. Let the embryo sit for about one week. Record changes via microscope camera.
6. Repeat for each solution.

Results

<table>
<thead>
<tr>
<th>pH</th>
<th>Unhatched</th>
<th>Hatched</th>
<th>Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>0/25</td>
<td>24/25</td>
<td>1/25</td>
</tr>
<tr>
<td>6.12</td>
<td>0/12</td>
<td>12/12</td>
<td>0/12</td>
</tr>
<tr>
<td>6</td>
<td>0/12</td>
<td>12/12</td>
<td>0/12</td>
</tr>
<tr>
<td>5.5</td>
<td>0/12</td>
<td>8/12</td>
<td>0/12</td>
</tr>
<tr>
<td>5</td>
<td>0/12</td>
<td>8/12</td>
<td>0/12</td>
</tr>
<tr>
<td>4.4</td>
<td>0/12</td>
<td>12/12</td>
<td>0/12</td>
</tr>
</tbody>
</table>

Embryos began to die as the pH decreased, to the point that all fish died during the test.

Conclusion

The results of this experiment supported the alternative hypothesis, as a decrease of water pH greatly decreased the percentage of embryos that survived. The fish began to die at a pH of about 5, though this may be an error as all the fish survived at a pH of 5.5. However, at the lower pH solutions, the majority, if not all of the fish died in the tests. Fish are more sensitive in lower pH, and their skin will burn as a result of a low pH. Acid rain is a serious environmental issue. The presence of sulfuric acid was used to simulate acid rain, and as the results show, if concentrated enough can significantly impact embryonic development of fish, or outright kill them.

References

- Effects of Acid Rain. (2017, June 1). Retrieved from https://www.epa.gov/apdrp/effects-acid-rain

Acknowledgements

- Mentor Steven Farber Ph.D. Principal Investigator, Carnegie Institution for Science, Department of Embryology. Adjunct Professor, Johns Hopkins University, Department of Biology Director of Admissions CMDB Graduate Program, Johns Hopkins University, Department of Biology Scientific Advisor and Co-Founder, Project BioEYES
- Mr. Stickler for obtaining the zebrafish, reinforcing necessary skills needed to carry out the project, and providing the tools required.
Title  
Testing The Effect Of Temperature On 200 QX Drone Battery Life

Summary
Drones are used for many purposes including delivery, surveillance, emergency response, and even disaster relief. All of these applications require a heavy camera or sensor to be added to the drone, which is why establishing how temperature impacts a battery is important. Six different temperatures and three different battery types were tested while maintaining the same drone weight in order to ensure that any trend found is consistent.

The purpose of this project is to establish any relationship between the temperature of the drone’s battery and the flight duration of the drone. The data revealed that Lithium Polymer was the most efficient battery in temperatures below 7°C, while Nickel Metal Hydride performed the worst in cold weather. All three battery types had nearly equal performance in temperatures between 7°C and 20°C.
Testing The Effect Of Temperature On 200 QX Drone Battery Life

Sean Nolan

STEM Academy, Rising Sun High School

Abstract
Drones are used for many purposes, including delivery, surveillance, emergency response, and even drone relief. However, all of these applications require a heavy camera or sensor to be added to the drone, which is why establishing how temperature impacts a battery’s life is crucial. In the experiment, three different battery types were tested while maintaining the same drone weight in order to ensure that any trend found is consistent. The purpose of this project is to establish any relationship between the temperature of the drone’s battery and the flight duration of the drone. The data revealed that Lithium Polymer was the most efficient battery in temperatures between 7°C, while Nickel Metal Hydride performed the worst in cold weather. All three battery types had nearly equal performance in temperatures between 27°C and 20°C.

Hypotheses
Null: There is no relationship between the temperature of the drone’s battery and the flight duration of the drone.
Alternative: There is a direct relationship between the temperature of the drone’s battery and the flight duration of the drone.

Introduction
The Blade 200 QX is a small commercial drone, which will be controlled by the three different types of batteries being used: Lithium Polymer, Nickel Cadmium, and Nickel Metal Hydride. Each battery has an electric charge of 1000 mAh (milliampere hour), a unit which generally measures the energy capacity of a battery (2015). A study conducted by Sung-Hyun, Joon (2016) at the King University regarding the impact of temperature on a battery’s life found that as the temperature increased, the duration of the battery decreased. This is a key question in advancing drone technology, as temperature often affects the duration of drones due to extreme temperatures hurting the battery. These applications include geospatial surveying, monitoring livestock and agriculture, and even used for recreational uses such as drone races. Additionally, there are drone types which are designed for aerial photography, which is why determining the impact of temperature on their batteries duration is crucial.

Methodology
Setup: Prior to any testing, the drone needed to be bound to the Spectrum DX8 transmitter. This was done by programming on the drone and ensuring the center light was blue, representing bound mode. Then, the transmitter button on the transmitter was held down until binding began. Additionally, the drone weight needed to be in line with the test, to which was done by adding small weights to the two binding weights until they weighed the same as the heaviest battery.

Results
The data revealed that higher temperatures lead to a higher battery duration, though the relationship between temperature and duration is not linear. At temperatures between 0°C and 20°C, the duration follows a nearly logarithmic curve. The battery duration is around 320 s at 0°C and 390 s at 20°C, which is a large difference from their durations at 20°C of about 245 s. At temperatures below 0°C, the duration continues to decrease but at a much slower rate. The data also revealed that Lithium Polymer is the most efficient battery composition in cold weather, with a duration of about 135 s at a temperature of -10°C compared to durations of 190 and 122 s with Nickel Cadmium and Nickel Metal Hydride batteries. This trend was consistent at 0°C, although the difference in durations became much smaller. Additionally, Nickel Metal Hydride appeared to perform the best in temperatures ranging from 0°C to 25°C while Lithium Polymer and Nickel Cadmium performed slightly worse. However, the performance of each battery around this temperature only has a difference of about 3 seconds compared to the other batteries.

Conclusions
In conclusion, the results reveal that there is a clear direct relationship between temperature and battery duration. The data also revealed that Lithium Polymer’s rank correlation coefficient proved that each battery has a strong positive correlation regarding temperature and duration, accepting the null hypothesis as an alternative hypothesis. However, because the test temperatures only range from slightly below freezing to room temperature, warm temperatures may have produced a different relationship. The results also revealed that there is no significant difference in the performance between the different battery types at temperatures above freezing. However, at temperatures below freezing, Lithium Polymer proves to be the most efficient battery with a duration of at least 138 seconds, followed by Nickel Cadmium and Nickel Metal Hydride with durations of 130 and 126 seconds respectively.

References

Acknowledgements
AS AAM Institute of Aeronautics and Astronautics Grant for funds to purchase some necessary materials and equipment. ATG AOPC for funding drone evolution for school year. McGeorge Jacobsen Army AB, Avionics Engineer for being mentor and for providing ideas and helping with the project. Mr. Gregg Sicker for assisting and guiding throughout the process of the project. MCAH for helping with the setup of the project.
Title  How Sugar Contributes to Tooth Decay and How to Prevent it

Summary
You are always told at dentist’s offices to drink fewer sugary drinks, but what exactly is that?

Bacteria in your mouth actually feed off sugars which in turn releases acids that corrode your teeth. That’s why people who have high sugar intakes often have cavities and teen complications.

This experiment examined the deteriorating effects of sugar from common drinks and effectiveness of fluoride coatings.
How Sugar Contributes to Tooth Decay and How to Prevent it
Christopher Oh
CCPS STEM Academy Rising Sun High School

Abstract
You are always told at dentist’s offices to drink fewer sugary drinks, but why exactly is that? Bacteria in your mouth actually feed off sugars while eating away at our teeth. (Name) is the hardest and most outer part of the tooth and is made of calcium phosphate (Hoffman). It covers and protects our teeth from foreign substances but once damaged it cannot be restored. Under the enamel is dentin which is a hard tissue; under the dentin is dental pulp which is the softer inner structure of the tooth, containing blood vessels and nerves (Hoffman). As bacteria metabolizes the sugar, lactic acid is released (Dentacure.com) and will begin to breakdown enamel creating small packets of decay (Oralrn.com). These small packets of decay are known as cavities. These cavities often get severe, infecting dental pulp in the tooth, causing root canals to be needed. If left untreated, the bacteria will continue to metabolize sugars, further infecting the tooth, resulting in extraction of the tooth to prevent the infection from spreading. In a similar experiment, teeth were left in sodas and these came out discolored with less in mass up to 25% (Despak), in a case where a man had drank cola everyday, dental caries, and enamel erosion occur (Cheng). So we knew for sure that dentist health is negatively affected by these sugars. Further showing this idea, is an experiment done with eggs, where soda had corroded the shell, which is made of minerals found in teeth (hypocalcification). I selected dentistry because in the future I would like to pursue a career in the dental field and having an enthusing background. The purpose of this experiment is to see how sugars affect tooth decay, and how protective coatings prevent tooth decay. I think it would be interesting to see how teeth are affected by sugar, because popular consume sugary drinks and foods everyday, so I would want to see just how bad it really is. I also would like to see how taking preventative measures could shield teeth from decay. My project could show how to prevent dental problems involving decay. The null hypothesis is that sugary drinks will not have an effect on teeth decay and protective coatings will not have any effect on decay rates. The alternative hypothesis is that: sugary drinks will cause greater decay rates in teeth, causing teeth to lose mass, and protective coatings will prevent decay in teeth, causing teeth to lose significantly less mass compared to those without coatings.

Introduction
Half the American population drinks soda everyday (IncidentalScience.com). The sugar in soda feeds harmful bacteria which in turn cause bacteria to release acid that eats away at our teeth. (Name) is the hardest and most outer part of the tooth and is made of calcium phosphate (Hoffman). It covers and protects our teeth from foreign substances but once damaged it cannot be restored. Under the enamel is dentin which is a hard tissue; under the dentin is dental pulp which is the softer inner structure of the tooth, containing blood vessels and nerves (Hoffman). As bacteria metabolizes the sugar, lactic acid is released (Dentacure.com) and will begin to breakdown enamel creating small packets of decay (Oralrn.com). These small packets of decay are known as cavities. These cavities often get severe, infecting dental pulp in the tooth, causing root canals to be needed. If left untreated, the bacteria will continue to metabolize sugars, further infecting the tooth, resulting in extraction of the tooth to prevent the infection from spreading. In a similar experiment, teeth were left in sodas and these came out discolored with less in mass up to 25% (Despak), in a case where a man had drank cola everyday, dental caries, and enamel erosion occur (Cheng). So we knew for sure that dentist health is negatively affected by these sugars. Further showing this idea, is an experiment done with eggs, where soda had corroded the shell, which is made of minerals found in teeth (hypocalcification). I selected dentistry because in the future I would like to pursue a career in the dental field and having an enthusing background. The purpose of this experiment is to see how sugars affect tooth decay, and how protective coatings prevent tooth decay. I think it would be interesting to see how teeth are affected by sugar, because popular consume sugary drinks and foods everyday, so I would want to see just how bad it really is. I also would like to see how taking preventative measures could shield teeth from decay. My project could show how to prevent dental problems involving decay. The null hypothesis is that sugary drinks will not have an effect on teeth decay and protective coatings will not have any effect on decay rates. The alternative hypothesis is that: sugary drinks will cause greater decay rates in teeth, causing teeth to lose mass, and protective coatings will prevent decay in teeth, causing teeth to lose significantly less mass compared to those without coatings.

Methodology
1. Take initial observations and mass of each tooth
2. Grow bacteria cultures, for inoculating teeth. Done by creating a nutrient rich broth that bacteria can feed off.
3. For each set of two teeth, coat one in fluoride
4. Use cotton swabs to coat each tooth with bacterial solution.
5. Put a set of two teeth in a corresponding solution.
6. Leave set of teeth in incubator for four days at 37° C.
7. Take out teeth after the allotted time has passed and take the masses/observations, record the data
8. Repeat 2-7 for additional testing.

Materials:
- Deer teeth
- Streptococcus Mutans bacteria
- Coca-Cola
- Gatorade
- Orange Juice
- Water
- Fluoride paste

Independent variable: Type of drink used to feed bacteria, different coatings used to protect teeth

Results

Conclusions
Although the Coca-Cola eroded the teeth regardless of whether or not a fluoride coating was applied, from the trials with the orange juice and gatorade, it can be concluded that a fluoride coating does help better protect teeth from decay. The teeth dipped in water did not really lose or gain mass which was expected. The untreated teeth in orange juice and gatorade lost almost twice the amount of mass, while the treated teeth lost 50% less mass. The teeth in coca-cola, however all lost around the same amount of mass. it can be hypothesized that as the lowest pH solution the coke may have eroded through the fluoride. The results then support the alternative hypothesis because there is a difference in decay when fluoride is applied.

Reference
-What does soda do to your teeth? (n.d.). Retrieved from health.com

Acknowledgements
Dr Melissa Lee DDS Mentor Bucklands Deer Processing for providing Deer heads for teeth. Mr. Stolick for helping throughout the project.
Title: What is the Best Way to Get Rid of Acne and Can it be Used Forever?

Summary
The purpose of this project is to determine whether more expensive acne medications really work better than a cheaper at home remedy.

A control group will be tested where no treatment is applied to the agar plate and the bacteria will just grow with nothing stopping it.

After testing it was shown that Glycolic Acid and Apple Cider Vinegar were the best in their categories. The second part of the experiment is to see if the bacteria which causes acne builds immunity to treatments used to kill them. The purpose of this is to see if there is just one treatment plan that can be stuck to forever or if maybe changes need to be made and multiple treatment plans need to be made over the years. The same trials will be done just instead of using every treatment plan, only the best from each category (medication and home remedies) will be used. This experiment may need to be done multiple times do to immunity not being easy to see a trend.
What is the Best Way to Get Rid of Acne and Can it be Used Forever?

By: Matthew Renzo
Mentor: Mrs. Alena Calm
US Army RDECOM
Teacher: Gregg Sticker

Abstract

The purpose of this project is to determine whether more expensive acne medications really work better than cheaper alternatives. If the medication really does work better, then people will be willing to pay more money for acne medication. The hypothesis is that the more expensive treatments are better than the cheaper medications. The null hypothesis is that the more expensive treatments are no better than the cheaper medications.

Methodology

Introduction

Acne is a skin condition that occurs when hair follicles become clogged with an excess of dead skin cells, oil, and bacteria. It is a common skin problem that affects people of all ages and skin types. Acne medication is usually prescribed in the form of creams or lotions to be applied directly to the skin.

Steps of how acne forms

1. Hair follicles produce oil
2. Dead cells and bacteria become trapped
3. Inflammation occurs

Effects which increase and add to the lesions are shown to make it more severe:

- Bacteria
- Hormones
- Genetics

Risks of untreated acne:

- Psychological impacts
- Physical scarring

Results

Oxyacne Acid killed the most bacteria compared to the new Sulfur. Sulfur proved to be the most effective because it was used in all four plates but only one made it to the next step.

Histology

Histology will be used to evaluate the skin tissue. The skin will be removed and prepared for histological examination. The histological sections will be stained with hematoxylin and eosin to visualize the tissue architecture. The sections will be observed under a microscope to assess the changes in the skin tissue.

References

Title  
Grocery store sanitation and its effectiveness on metal and plastic components of shopping carts

Summary
Shopping cart handles are hosts for all types of bacteria. Grocery stores have provided sanitation wipes for customers’ use in cleaning the cart before interaction to reduce the amount of cross-contamination that can occur.

It is important to know how well the different parts of the handle, plastic and metal, sanitizes because the customer can touch the part that is the most clean, and cut down on the spread of bacteria. This is especially important in today’s society where we are being faced with a worldwide pandemic.

Heterotrophic Plate Count, HPC, samplers are an easy way to grow bacteria from a liquid sample and examine the colony growth from the swab.
Introduction

Shopping cart handles are hosts for all types of bacteria. These organisms can contaminate food and hands, giving sickness to grocery people who interact with the surfaces. Grocery stores have provided sanitization wipes for customers’ use in cleaning the cart before interaction to reduce the amount of cross-contamination that can occur.

It is important to know that all the different parts of the handles, plastic and metal, sometimes because the customer can touch the part that is the most clean, and cut down on the spread of bacteria. This can improve public health, and create an overall safer environment for everyone. This is especially important in today’s society where we are being faced with a worldwide pandemic. COVID-19 can be avoided with proper health practices, so knowing what surfaces are the cleanest or the dirtiest shows people what to be more careful around.

Heterotrophic Plate Count, or HPC, samples are an easy way to grow bacteria from a liquid sample and examine the colony growth from the swab.

Materials and Methods

- Personal Protective Equipment
- Disinfectant
- Shopping Cart
-浦手 Sanitize Wipes
- HPC Sampler - 25
- Seed Water - 25 tubes, 15.5 mL each
- 18 Nutrient Agar Powder
- Sterile Cotton Swabs
- Camera
- Exel Random Number Generator

Results

Both surfaces sanitized efficiently with there being a difference in dirty and clean values in both. Metal surfaces had an overall bigger difference between the dirty and clean.

Conclusions

The samples in this experiment showed that metal surfaces had less bacteria after sanitizing compared to plastic surfaces. This shows that metal surfaces sanitized better. This is due to the absence of pores on the metal. The smooth surface allows bacteria to be easily wiped away, leaving the handle cleaner than a plastic surface wiped also.

If the experiment were to be done again, I would change the number of trials I completed. I would increase the number of data points to make the results more accurate. There may have been some error in the way the carts were sanitized. They were sanitized in the grocery store, so some sterile samples may have been compromised, leading to inaccurate data.

Literature Cited


Acknowledgments

I thank CST’s PLTW Biomedical Sciences instructor, Wendy Parmer for the guidance on completing this project. I also thank Erinment Dykes at the University of Delaware Biotechnology Institute for her expertise and advice in using the scientific method.

For further information

Please contact shyann.peterson.13@rj.edu for more information on this Capstone project.
Title  How Does the Amount of Amps and Type of Chemicals Added Affect the Rate of Electrolysis?

Summary

Question of my capstone project is: How does the amount of amps and type of chemicals added affect the rate of electrolysis? This can solve a real world problem because rust is a problem all across the world. By using this process of electrolysis, it can save the metal instead of throwing it away. It can be reused after going through the de-rusting process of electrolysis.

My null hypotheses are: the type of chemical will not cause a significant change in the mass of the final piece and The amount of amps will not cause a significant change in the mass of the final piece. In my tanks the reactions that are occurring are called oxidation-reduction reactions or known as redox reactions.
How Does the Amount of Amps and Type of Chemicals Added Affect the Rate of Electrolysis?

Nathan Sexton, Grade 11
CCPS STEM Academy, Rising Sun High School, North East, Maryland

Abstract

This project is to see how changing the type of chemical and the amount of amps affects the rate of electrolysis. Electrolysis is a process of removing impurities from a solid material by passing an electric current through it. This experiment was to see what the differences are in the rate of the reaction when changing the type of chemical and the amount of amps. The hypothesis was that more amps will increase the rate of reaction because it will create more electron flow. 2 electrodes were used, one held a 0.2M solution of sodium hydroxide and the other held a 0.2M solution of copper nitrate. 3 set of experiments were done, one with the amp set to 0.05, one with 0.15, and the other with 0.25. Each of the experiments were ran for an equal amount of time and it was measured. The conclusion was that more amps increase the rate of reaction.

Materials

- Electrolytes
- Copper wire
- Electrolysis cell

Methods

1. Set up the electrolysis cell with 2 electrodes, one holding a 0.2M solution of sodium hydroxide and the other holding a 0.2M solution of copper nitrate.
2. Connect the electrodes to a power source.
3. Measure the current flow for 5 minutes.
4. Record the amount of gas produced.

Discussion/Conclusion

Increasing the amount of amps increased the rate of reaction. This is because more electron flow occurs, thus increasing the rate of the reaction. However, the type of chemical did not affect the rate of reaction. This is because the type of chemical does not affect the flow of electrons. The hypothesis was correct because more amps did increase the rate of reaction.

Equation

Cu(N03)2(aq) + 2NaOH(aq) → Cu(OH)2(s) + 2NaNO3(aq)

Cathode: Cu2+ + 2e- → Cu
Anode: 2OH- → H2O + O2 + 4e-

Glossary

Electrolysis: The process of separating one or more chemical elements from a compound by passing an electric current through it. Electrolytes: Substances that conduct electricity when dissolved in a solvent. Electrolysis cell: A device used to perform electrolysis experiments. Power source: A device that provides the necessary electrical energy to perform electrolysis experiments.

Citations


Dr. Alice K. Bohm, "Electrolysis," The Franklin Institute, https://www.fi.edu/exhibit/energy/energy-matters/chemical-energy/electrolysis.html
Title  How nose cone and fin shape affect the maximum altitude, maximum velocity, maximum acceleration, and coast time of a model rocket launch

Summary
The purpose of this experiment was to see how aerodynamics affect a model rocket launch. More specifically, to see how changes in the shape of the nose cone and fins affect the maximum launch altitude, acceleration, velocity, and coast time with the accessory change being the independent variable and the launch behavior being the dependent.

The dependent variables should benefit from the accessory changes because the accessory changes should reduce the amount of drag (air resistance) on the rocket.

It was concluded that, out of the fins, the elliptical fin had the least amount of drag, followed by the square fins, and the trapezoidal fins had the highest average drag. Out of the nose cones, the pointed nose had the least average drag, followed by the rounded nose, with the blunt nose having the highest average drag.

After the launches, it was concluded that, out of the fins, the elliptical fins performed best, followed by the trapezoidal, then the control group. Out of the nose cones, the rounded nose performed the best, followed by the pointed nose, with the control in last.
Abstract
The purpose of this experiment was to see how aerodynamics affect a model rocket launch. More specifically, to see how changes in the shape of the nose cone and fins affect the maximum launch altitude, velocity, and cost time of a model rocket. The dependent variables should benefit from the accessory changes because the accessory changes should reduce the amount of drag (by reducing the cross-sectional area) and increase the lift force. The independent variables to be measured in a wind tunnel are the average amount of drag and the average amount of lift was calculated. The force was measured in Newtons (N). The wind speed was calculated using the equation below which was used to calculate the wind speed. The second part of the experiment was live launches. The rocket was launched at 15,000 RPM and the data was collected using an altimeter that was embedded inside the rocket during the launches.

Methodology

Accessory Creation:
- Create a barrel made out of a plastic pipe, a metal frame to hold the plastic pipe, and a metal frame to hold the fins.
- Attach the fins to the metal frame using a screw that is embedded inside the rocket during the launches.

Wind tunnel testing:
- Use the wind tunnel to test the rocket.
- Measure the lift and drag forces on the rocket.
- Use the data to calculate the efficiency of the rocket.

Results

Conclusion
After analyzing the results, it was clear that the null hypothesis was rejected and the alternative hypothesis was supported. The null hypothesis stated that there is no difference in the flight characteristics of the rockets with and without the fins. The alternative hypothesis stated that there is a difference in the flight characteristics of the rockets with and without the fins. The火箭 with and without the fins had different results. Because of this experiment, it is now clear that a model rocket’s flight characteristics do not solely depend on engine size. Engineers will save money on rocket fuel prices by spending money to have the right rocket accessories.

References

Acknowledgements
- Dr. Schultz, College – Project Mentor
- AAIA, American Institute of Aeronautics and Astronautics – Grant Funding for all materials and supplies
- Mr. Stickler – project support
Title  The correlation between pitch and decibels and how they are impacted by soundproofing mediums

Summary
Sound is all around us but, sound can be a nuisance and can interfere with other sounds and bring discomfort to a listener. Initially this project was created to test how different pitches will be measured in a bin filled with different materials, including foam and plasterboard, to see how well they absorb the volume.

However, due to COVID-19 this project was altered drastically. Due to the virus, not enough data was collected to see the changes in waves by the change in material and frequency tested.

Fortunately, there was enough data to compare the amplitudes and therefore the volume of different frequencies.
The correlation between pitch and decibels and how they are impacted by soundproofing mediums

By: Charlie Teague
Rising Sun High School STEAM Academy

Materials Used:
- Vernier Microphone
- Constructed Foam Box
- Iphone 6s
- Egg Cartons
- Logger Pro

Initial Methodology/Procedure

- Place speaker inside specially crafted foam box
- Insert versus microphone inside box and measure the frequency and decibel for 30 seconds by playing a sound from the phone
- Repeat with other materials and soundproofing mediums
- The wavelengths will be graphed on Logger Pro and analyzed

Results

- The higher the frequency of the sound wave, the shorter the wavelength of the sound wave.
- The higher the frequency, the shorter the wavelength.
- The phenomenon of sound absorption occurs because of the relationship between the direction of the sound wave and the medium.

Hypothesis/Introduction

The null hypothesis of this project is that there is no correlation between the type of material and the change of pitch. Materials include: foam, egg cartons, heavy blankets, acoustic panels, etc. The alternative hypothesis is that the density of the material increases the amount of sound absorbed and will increase because there is more material present.

This graph represents the medium which the sound waves are passed through, the differences in volume and the effect of sound absorbed by the medium.

The higher the frequency, the shorter the wavelength.

Comparing the coefficient of sound absorption between acoustic panels and foam.

This bar graph shows how effective these materials are at absorbing sound, as they are used in theaters where controlling sound is essential.

Data was arranged into tables with five trials in each table and five types of each table. All in all there were twenty five trials for each frequency. In an environment, for example, there are 25 trials of 432 hertz constant environments. Results were varied due to COVID-19. It was expected to compare the change in amplitude based on the material and frequency, however these results only depict the constant trials and how the frequency changes based on hertz.

Conclusion

In conclusion, due to the virus, this project was turned around. Nonetheless there is conclusive evidence supporting the claim that frequency does impact the pitch. However, due to the constant volume of the pitch, the higher the pitch, the louder the volume. Due to this fact, there is no surprise that music producers and musicians are forced to use very tight materials like foam and close to sound from escaping or re-echoing. Additionally, it is also necessary that the foam was used due to human error. There is no reason why 432 hz should have a higher amplitude than 440 hz, therefore making the pitch higher. Additionally, the opportunity to use foam was limited due to the space and therefore was limited. However, the use of foam can be increased if there were foam materials being picked up by the microphone besides the pure tone frequency. Additionally, the opportunity to use foam was limited due to the space and therefore was limited.

Acknowledgments

I would like to thank Mr. Greg Sivick for being so patient with me and my project. I would also like to thank Ms. Thelma Cheek, my music teacher for allowing me to use the practice room in the band room to conduct the research. Finally, I would like to thank Chad Glyn (music producer) for giving me input on how to soundproof efficiently.

Citations

Title  
Cognitive Success Rates with Assistive Technology

Summary
My project is about how the brain works with different assistive technology. One of the assistive technologies that will be used is text to speech, where the text is in front of them and they just listen and follow along to see if listening to it is better than reading it.

Then another assistive technology that will be used is a video, the video is going to show pictures of what they read while listening to it too. But as a control we will have them read the article by themselves.

The main goal of my project it to see which is better: reading, listening, or seeing and listening.
Cognitive Success Rates with Assistive Technology

By: Brianna Thornton
CCPS STEM Academy
Rising Sun High School

Abstract

My project is about how the brain works with different assistive technologies. One of the assistive technologies that were used is text-to-speech, where the text is in front of them and they just listen and follow along. We see if they feel that is better than reading it. Then another assistive technology that was used is a video, where they can see the pictures of what they are reading while listening to it. But, as a control, we will have them read the article by themselves. The main goal of my project is to see which is better: reading, listening, or seeing and listening.

Methodology

1. Identification of three different classes to participate with teacher agreement. One on a grade level, one honors, and one AP.
2. Selection of three different lists and creation of three delivery methods:
   a. Written list
   b. Audio file for list
   c. Video file for list
3. One list with three different ways: Reading, Listening, Video.
   a. There will be one list that is on slides and it will be read, which has all three different vocabulary levels. They will read each slide for 6 seconds then it goes to the next slide. The total time of the slides was 2 minutes and 52 seconds.
   b. There will be another list that students will get to see while they listen, which also has different vocabulary levels. The audio section will last for 3 minutes and 13 seconds.
   c. There will be a video about a different list with pictures and text-to-speech (TTS), again having different vocabulary levels. This video section will last about 3 minutes 12 seconds.
4. Creation of Assessments and Scoring:
   a. Creating the assessments by giving the students the first word and they will have to write the correct second word. The students will get 1 point for trying the word and 3 if they get it right. There are a total of all points for each list.
5. Comparing Scores between content delivery methods:
   a. It will be very similar to a regular test, scoring wise. By taking the point amount they got correct and dividing it by 45 because the test is out of 45 points. But once the test scores came back, we will average it out for comparison. This will happen for all content delivery methods. Then, on a different sheet we will monitor the changes individually to see if it was the whole class or just certain people.

Hypothesis

Null Hypothesis: It is hypothesized that there is a direct relationship between using text-to-speech and their test scores are going to be.

Alternative Hypothesis: The hypothesis of this research project is different statistics that using different test to speech will cause a significant change in the students test scores.

Impact of School Closure on Project

At the time of school closure, I had finished making all of the testing items which included the Reading, Listening, and Watching, and Listening. I had collected a lot of data from one class and partial data from another. I had planned to collect data from two more classes but the closure ended my data collection. Because of that, I have less data to use and my conclusions will not be as meaningful.

Visual Average, Audio Average and Video Average

<table>
<thead>
<tr>
<th></th>
<th>Visual Average</th>
<th>Audio Average</th>
<th>Video Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM 5A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>21%</td>
<td>23%</td>
<td>26%</td>
</tr>
<tr>
<td>Listening</td>
<td>26%</td>
<td>24%</td>
<td>23%</td>
</tr>
<tr>
<td>Watching and Listening</td>
<td>25%</td>
<td>24%</td>
<td>23%</td>
</tr>
<tr>
<td>Total Average Percent</td>
<td>22%</td>
<td>23%</td>
<td>24%</td>
</tr>
</tbody>
</table>

When doing this experiment, my null hypothesis was that there is no relationship between learning type and test scores. The alternative hypothesis was there is a direct relationship between using text-to-speech and what their test scores are going to be.

The limited data that was collected is non-statistical. The data from STEM 5A supports the alternative hypothesis because there is a significant difference between learning types. STEM 4A shows no difference so supports the Null hypothesis.

In order to draw more meaningful conclusions data from more students and more classes would need to be collected.

References


Acknowledgements

- I would like to thank Mr. Stidler for making this all possible and for pushing me to think outside the box and for believing in me.
- I would also like to thank my mentor, Dr. Moore. Thank you for helping me think things through and for being there for my questions.
Title  Does Increasing the Temperature of the Water Affect the Growth and Health of Triploid Rainbow Trout?

Summary
My Capstone Project is how Triploid Rainbow Trout is affected when the temperature of water rises. I measured the fish’s activity levels, weight, length, and mortality. The purpose of the project is to supply Trout Unlimited and Maryland DNR with data on what happens when the temperature is raised.

My conclusion on the project is that when the temperature is raised, the fish will grow faster than the ones in the cold water, the warmer tank is more active, and the tank that is colder had a higher mortality.
Does Increasing the Temperature of the Water Affect the Growth and Health of Triploid Rainbow Trout?

Madeline Warnick
Rising Sun High School
CCPS STEM Academy

Abstract

My Capstone Project is to look at Triploid Rainbow Trout affected when the temperature of water rises. I measured the fish’s activity levels, weight, length, and mortality. The purpose of the project is to support the Maryland Unlimted and Maryland DNR with data on what happens when the temperature is raised. My conclusion on the project is that when the temperature is raised, the fish will grow faster than the ones in the cold water, the warmer tank is more active, and the tank that is colder had a higher mortality.

Hypotheses

The null hypothesis is when raising the temperature of water, the health and growth of the fish will not be affected. The alternative hypothesis is if you raise the temperature of water, then the trout growth and health will increase because trout hatch faster in warmer water.

Methodology

1. Set up two 55-gallon tanks. Both tanks should be set up according to the Trout in the Classroom Manual.
2. On the day of arrival, the eggs will be put into the breeder basket.
3. Daily from the day the eggs arrive, the mortality of the eggs must be monitored.
4. When the fish hatch, take 5 random fish out of the breeder basket and measure their length and weight.

a. To measure their length:
   i. Take a petri dish and fill it with a little bit of water from the tank.
   ii. Take the fish and put it in the petri dish.
   iii. Take a ruler and measure the fish from head to tail in centimeters (cm).
   iv. To measure the weight:
      i. Thoroughly clean out a beaker.
      ii. Put the fish in the beaker and fill with water and put it on the scale.
      iii. Zero out the scale.
      iv. Add the fish to the beaker.
      v. Wash the weight of the fish in grams (g).

b. Do this with 5 fish that was used for the length measurements.
5. Weekly their activity level will be monitored by watching to see how long it takes 30 seconds the fish swims back and forth in the tank.

Analysis and Discussion

The data shown by the graphs present that the fish grew exponentially. If we continued collecting data, the graph would have shown a logistics curve. An exponential curve is when the data increases exponentially to infinity, while a logistics curve increases and ends up flattening out at a certain value. The fish cannot grow to an infinite size, there for will be a value where on average the fish will stop growing resulting in a logistics curve. In result, the temperature affects the growth and development after seeing that the 58 degree tank grew and developed much faster than those in the 52 degree tank.

Conclusion

In conclusion, the temperature had an affect on the trout growth and development. As the 58 degree tank would tend up being 2.3 times bigger than the 52 degree tank, the data supports my alternative hypothesis that the trout would grow faster in the warmer water. The null hypothesis was wrong because there was a difference in each of the tanks.

References

• DFG webmaster@alaska.gov (n.d.). Gene Conservation Laboratory - Triploid Rainbow Trout, Division of Commercial Fisheries, Alaska Department of Fish and Game. Retrieved November 1, 2019, from https://www.asdf.alaska.gov/index.cfm?ddf=fishing/geneconservatory/triploid_trout

 Acknowledgements

I would like to thank:
• Mr. Sticker for helping me with the project
• Chuck Dinke for allowing me to do the project
• STG for being my mentor on the project
• Katie Gibson for being my paper on the project
• Maryland’s Department of Natural Resources for providing me with the materials
Title  Does video technology help make weight lifting safer and more effective?

Summary
The independent variable will be whether or not video technology is used, and the dependent variable is going to be the increase in the amount of reps done on a weight (75 percent of body weight) for each exercise.

The control group is the group that will be doing the same exercises, but not using the video technology.

This applies to the real world because anyone could use the app to help make their lifting experience more effective and safe.
Does video technology help make weightlifting safer and more effective?

Jared Webb Rising Sun High school, Mentor Mr. Russell Moore CCPS

Abstract

The independent variable will be whether or not video technology is used, and the dependent variable is going to be the increase in the amount of reps done on a weight (15 percent of body weight) for each exercise. The exercises will be squat, deadlift, and bench press. The dependent variable is the amount of weight per exercise type recorded: recorded exercise, outside exercises, and the use of supplements. The control group will be the group that will be doing the same exercises, but not using the video technology. The control group is a group that has no comparison to the experiment group, but will have a comparison group. The group that will be using the video technology is a group that will have a comparison group, but will not have a control group. The group that is not using the video technology is a group that will have no comparison group. The experiment group is a group that will have a comparison group, but will not have a control group.

Hypothesis

The null hypothesis is that there are no correlations between video technology and weightlifting.

The alternative hypothesis is that video technology and weightlifting is effective and the scores of the students are directly proportional to the amount of weight used as well.

Materials

The most important material will be a place for your group to work out, that is easily accessible for everyone, and the actual participants doing the weight lifting. The school will be a place that is accessible to everyone, and the participants. Other materials consist of the IPad app, access to a bigger screen, and the way you print and distribution.

Methodology

To perform the project you need to, first download the IPad app, and get another feature. This will cost four dollars, and unblocks the graphs and recording of the information that you need such as weight, time, moisture, and vision. In order to find the optimal way to perform the exercises and find what your average weight, velocity, force, and acceleration is, you need to get a group together, record the video technology on your iPad, and the other half will not. For the record, you will have to record the speed at which you do the lift and the time the lift took you to do. You will then have to make a weight log book that will give you the average amount of weight you need to perform and record the amount of reps. You can then compare the amount of strength increase through apps from the group using the video technology to the group not using video technology.

Analysis

Looking over the data, you can see that the increase in reps for my 4A class, and the class that is using the video technology is increasing in the amount of reps increased faster. A bigger average increase in the amount of reps for the class that is using video technology is being shown to be true. This is also shown in the amount of reps increased with the data for the video technology class is increasing faster.

Conclusion

In conclusion, and even with a smaller amount of data, I was able to prove my hypothesis correct. That video technology can have and does have an impact on the amount of reps increased for 4A class. This is shown through the graphs and the bigger average increase in the amount of reps performed by 4A class over class 2A. As far as safety, both classes never had an injury when dealing with weightlifting. The biggest problem that I found was the amount of time that it took to record the video. It was most likely due to the shortened amount of time, but does not prove the second part of my hypothesis. That video technology will increase safety, it only shows that it makes my hypothesis in favor. There was also another factor that wasn’t ruled out, such as overall knowledge of weightlifting, some kids might have known the form better than others, so I was teaching 4A class with the technology, 2A might have been experts on each exercise performed.
Congratulations on your outstanding achievement and best wishes for success as you continue your journey.