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Leg-Up: Helping Youth Apply Engineering

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Leg-Up

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Background

Over the past decade, Dr. Tycho Fredericks and Dr. Steven Butt, of the College of Engineering and Applied Sciences, have had numerous interactions with middle school and high school students traveling through the College on outreach trips and recruiting visits. It was through these interactions that they noticed many students had difficulty applying basic math and science skills learned in school to solve open ended problems. More specifically, the students were not able to understand how to use the scientific method to solve design challenges (open-ended problems). In fact, when students were asked where they should use the scientific method, the most common response was – “in the science fair”. When asked where else one might use this type of methodology, the general response was a blank stare. Thus, there seemed to be a gap between what students were learning in the classroom and the application or utility of the knowledge in the real world. Leg-Up was created to fill that void.

Objective

Leg-Up was designed to immerse middle school students in real world problem solving. It allows students to select a problem they deem important and with the aid of mentors determine a solution via the scientific method.

Pilot - Participants

Four 8th graders from Paramount Charter Academy in Kalamazoo, Michigan participated in the inaugural year of Leg-Up. Permission to participate was granted by the students, parents, teachers, middle school dean, and principal of the school. To participate, the students chosen by the school had to commit to coming prepared to WMU once a week for a minimum of two hours from September through May.

Outline of Activities

- Ice Breaking Activities
- Team Forming
- Bug Lists & Brainstorming
- Identifying Opportunities
- Reading Materials
- Project Selection
- Construction of Hypotheses
- Literature Review
- Demonstrations
- Surveys
- Revision of Hypotheses
- Experimentation
- Interpretation
- Documentation & Presentations

Group 1: Effects of Drumming on the Body

Effects of Drumming On The Body
By Mitchell Betting and Lance Abbott

Our Problem

- Drummers get injuries and fatigue when they play.
- Thought we could create a bass pedal to keep drummers from getting fatigued when playing fast.

Research

- Looked at existing research articles and patents concerning our subject.
- Found out:
 - Drummers get lots of MSDs (Musculoskeletal Disorders)
 - Tendinitis
 - Carpal tunnel
 - Strains
 - There are ways to reduce this problem like stretching and changing posture.

Survey

Created survey to determine the areas of the body most affected by drumming.

Survey Results

- Surveyed 8 drummers
- Ages 11-42
- All males
- All had some type of pain
- Upper body pain most common

Experiment Objective

- To determine the effects of drumming on the upper extremities.

Important Muscles

Background

- Research - how can we measure muscle fatigue?
- EMG (electromyography)
 - Measures electrical impulses in the muscles

Methods and procedures.

- Set up drums
- Prepare camera and lighting
- Set up EMG
- Electrodes
- Open software and folders on computer
- Take subject/drum measurements

RESULTS (cont'd)
EMG Analysis

Average Percent Differences between Neutral and High

- Trapezius Muscle/High Tom = 44.79%
- Trapezius Muscle/Low Tom = 50.68%
- Deltoid Muscle/Low Tom = 44.26%

Average Percent Differences between Neutral and Low

- Trapezius Muscle/High Tom = 30.79%
- Trapezius Muscle/Low Tom = 17.71%
- Deltoid Muscle/Low Tom = 18.44%

RESULTS (cont'd)
3DSSP (3D Static Strength Prediction) Analysis

	Neutral	High Tom	Low Tom
Low Back Compression Force (lb)	179	128	104
Shear Force (lb)	19	15	09
Shoulder Strength Capability (lb)	99	99	99
Trunk Shoulder Joint Moments - Right (lb-ft)	180.0 (0)	173.0 (0)	162.0 (0)
Trunk Shoulder Joint Moments - Left (lb-ft)	180.0 (0)	163.0 (0)	162.0 (0)
Spine	162.0 (0)	152.0 (0)	150.0 (0)

CONCLUSION

- More stress on the trapezius and deltoid muscles
- When seat was lowered the stress went down by a very significant amount
- If we had more time on this project we would explore possible solutions
 - New kind of drumsticks
 - Different drum setup
 - New style of drums

Group 2: Do Moldy Reeds Cause Disease?

Our Wondrous WMU Journey
By Amanda Barkman and Kaylie Butt

What's the Problem?

- Identified potential projects with Lance and Mitchell
- Ideas considered: 3D movie effects on eyes, foot fatigue, airplane sickness, and more
- Our choice: DO MOLDY REEDS CAUSE DISEASE?

The Next Steps

- Initial questions:
 - What is on the reeds?
 - Is it mold?
 - Is it harmful?
 - Does it cause disease?

Moving Forward

- Literature Review (What was out there)
 - WMU library - current research articles
- Key Findings
 - Hand to mouth interaction can cause illness
 - Sharing can cause Hep. B and C, Thrush and many other diseases
 - Reeds are made of Arundo Donax (part of the bamboo family)
 - Found ways to kill common bacteria mold, and fungus in the mouth

Real World Survey Study

- Hypothesis - Organisms on reeds cause disease
- Surveyed our brass and reed players
 - Demographics (age, grade, gender, etc.)
 - Cleaning, sharing, and storing habits
 - How often were they sick
 - Still come to school
 - Stayed home
 - How long they use the same reed (reed players)

Band on Tape

- Filed band practice session
- Observations
 - Sharing instrument
 - Reeling reeds on music stands
 - Eating while playing
 - Handling reeds
 - Tapping reed against nose
 - Licking hands

Research Consultant

Dr. Todd Barkman - biologist from WMU (Biological Sciences Department)
Discussed how to identify what organisms were on the reeds
Taught us how to set up a controlled experiment
Built an experiment to be tested in the biology lab at WMU
But then...

Important Findings

- There are ways to keep a reed dry, dark, and cool when stored
- Staph. Epi. left on reeds can not be removed
- Influx itself into the dead plant cells of the reed
- Changes the reed vibration
- Cyclospores from saliva build up on reed surface, and change reed vibration
- pH changes make reeds brittle (teach cell materials)

On the Road of Experimentation

- Home remedies tested
- Remedies considered - antimicrobial/antifungal
 - Coconut oil
 - Tea tree oil (with water)
 - Lemon juice
 - Apple cider vinegar
 - Vanilla (with water)
 - Peppermint oil (with water)
 - Honey

Remedies break down

REMEDY	Survived 24hrs	Antimicrobial/Fungal	Change	pH	Notes
Vinegar	✓	✓	✓	Acidic (pH)	Poor
Tea tree oil	✓	✓	✓	Acidic (pH)	Poor
Coconut oil	✓	✓	✓	Acidic (pH)	OK
Honey	✓	✓	✓	Acidic (pH)	Good
Vanilla	✓	✓	✓	Acidic (pH)	OK
Apple	✓	✓	✓	Acidic (pH)	Poor
Peppermint oil	✓	✓	✓	Acidic (pH)	OK
Lemon juice	✓	✓	✓	Acidic (pH)	OK

Design Challenge

- Design a method/product to lengthen the life of reeds
- Devise a way to:
 - Remove organisms
 - Remove build up
 - Restore to original reed pH
 - Sanitize

Remedy Procedure

- Took picture of new clarinet reed
- Placed reed in vial with remedy substance
- Left for 1 week
- Removed and compared to previous pictures

Testing Reed pH Changes

- Wet new reed with distilled water and tested the pH
- average pH = 7.3
- Tested pH of new reeds after being in our mouths
- average pH = 7.8
- Tested different lemon juice solutions to try to return reed to original pH

Recommendations for Product Use

- After each reed use:
 - Remove reed from mouthpiece
 - Spray with lemon juice solution
 - Wipe lemon juice solution off with single use sterile gauze pad
 - Store in appropriate case (desiccant case)

Future Work

- Complete a controlled study using our methodology to see if truly lengthens the life of a reed
- Market?

Lessons Learned

There were many insights gained by both mentors and students. Some of those points are enumerated below:

From the students' perspective:

- Research can be fun
- An investigation ultimately leads to more questions
- You do not have to have all the answers, but you have to know where to look for quality information
- WMU is great
- Math and Science may now be the career of choice

From the mentors' perspective:

- Treat the middle school students like college students and they will respond like college students
- The experience leads to enormous opportunities for teachable moments
- With a little assistance to get started, middle school students were very capable of performing at what is usually seen as college level.
- The students were open to many possibilities and their project research typically crossed disciplines.
- It was fun and rewarding
- This age group can be more creative than college students

Next Steps

At the end of the year, the four students were required to present their projects to the 6th, 7th, and 8th graders and faculty at Paramount Charter Academy (> 200 students). The response from the students, faculty, and parents to their presentation was amazing. At first, we were unsure of how the students would react to presenting in front of such a large crowd, but both student teams seemed to thrive on the excitement. The teams did such a great job that there was no need to advertise this year for the new cohort. Paramount Charter Academy had to develop their own application process to deal with the number of students requesting to get into this program. This year, another team from the Gagie School will be added to Leg-Up along with two teams from Paramount.

It is also worth mentioning that the Kalamazoo Gazette and WWMT News Channel 3 both did short news pieces on this program last year. The Gazette coverage was picked up by the American Society of Engineering Education's media arm which further disseminated this endeavor internationally.

Acknowledgments

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