

Presenters: Michele Grimm, University at Albany

Topic: Teaching Biomechanics: Creating an Interactive Laboratory Experience

Resources:

- Biomechanics for Dummies - <https://www.dummies.com/book/academics-the-arts/science/biology/biomechanics-for-dummies-281998/>
- Phase 1 Paper: <https://journals.humankinetics.com/view/journals/jab/37/2/article-p163.xml>
- Hall, Hamill Knudson Textbooks:
 - Hall: <https://www.mheducation.com/highered/product/basic-biomechanics-hall/M9781259913877.html>
 - Hamill: <https://www.amazon.com/Biomechanical-Basis-Movement-Joseph-Hamill/dp/1451177305>
 - Knudson: <https://link.springer.com/book/10.1007/978-0-387-49312-1>
- Jupiter Notebook: <https://jupyter.org/>
- Google CodeLab: <https://codelabs.developers.google.com/>
- GitHub of Virtual Biomechanics Laboratory described in Presentation:
- <https://github.com/GrimmLab2019/elimays.github.io>

Presentation Overview:

- Course Structure:
 - Lectures
 - Homework – solving problems with defined exercises
 - Lab Exercises: follow defined process to learn
 - Open Ended Problems
- Challenges
 - Large enrollments – scalability
 - Online courses – active learning components
 - Team activities – assessment of individuals' learning
- Opportunity
 - Can we develop a way to support student learning through
 - Individual activity
 - Engage students
 - Open-ended problem
 - Scalable to any class size
 - Includes analysis that mimics a lab experience
 - IDEAL – interactive digital experience as an alternative laboratory
- Gamified Structure
 - Choose your own adventure
 - Oregon Trail
 - Phoenix Write: Ace Attorney
- ME 495 at Michigan State University in 2020
 - Assessment – identify anatomy, failure mechanisms of bones
 - Assignment – hired by police department to characterize injured individual
- Phase 1: all materials available in static form – interviews/xrays/victim information sheet/environment photo
 - Post-doc acted as “Dr Knows-More” and made herself available 9-5pm on weekdays and respond to questions or more information
 - Having stock photos of individuals had issues so switched to cartoon without any race identified

- Witness interviews presented as police notes and said camera footage with feet/gait data was available
 - Collected gait data of different people using Biopac system
- Phase 2:
 - Further gamification, advance it in time to 2320 with new race of aliens
 - Developed investigator terminal to provide information to students
 - Case Report
 - Audio patient interviews with subtitles
 - Additional evidence: x-ray, footprints, camera surveillance (gait data), shoes, heights, medical
 - Prior day security camera footage – shows characters have same appearance in terms of legs to show legs day of accident to be able to make only feet visible (limit information) and provide them with gait data
 - Provided with basic reference on gait analysis and which parameters can be used to recognize individuals based on their gait
- Individualized Problems
 - 17 scenarios – each assigned to 2 students
 - 4 Fracture Types
 - Can talk about general concepts with each other without sharing work and had to be documented in report they gave
 - Can interview other people as experts (doctors) to get more information and had to be documented in reports
- Evaluation of Impact
 - Phase 1- published in Applied Biomechanics Journal, students who requested all of the data on their own had higher scores on the assignment
 - Surveys revealed that they liked solving problems on their own and increased their understanding of the material from lecture, and were motivated to conduct the research
 - Students like gamified assignments, encouraged self-directed learning, allowed them to fill in the blanks of their assumptions
- Original Challenges
 - Worked as an online class and integrated active learning
 - Self-paced, supported multiple learning styles
 - Can include a variety of laboratory features that are scalable

Discussion:

- Timeframe – 3 weeks
- Age – senior mechanical engineering students
- Feedback on 58% being fun – postdoc stated students are used to having assignments with defined answers and this was out of this mold
 - Students are uncomfortable in open-ended questions space because they are too worried about their grades and the outcome
- Active Learning Activities for Biomechanics:
 - Case studies, free body diagram yoga, biomechanics laboratory – structures and materials lab such as chicken bone with vinegar and bleach and test them after modeling to see differences, 3d print things/cad with simulations of stress/strain in cad and compare to real life, make silly putty and make bones that were natural, dried or decalcified to see what the makeup of bones were and their structure, viscoelasticity lab with gummy worms/tootsie roles/etc.
- Textbooks:
 - Most don't have or use a textbook
 - Where do they learn about trusses? Issue is there aren't good books some are too for kinesthesiology
 - Hall, Hamill Knudson

- Anyone use ODEs/Matlab/Python?
 - Use python to fit data
- What do you decide what is core vs secondary since there are so many topics?
 - Dependent on curriculum and there's no way to cover everything, but they should understand that tissues respond to stresses and are dynamic and there are factors that effect tissue properties. They are not homogenous and not isotropic, and pick which tissues are interested based on curriculum
 - Examples – cardiac biomechanics, orthopedic biomechanics, soft tissues such as brain
- Student Buy-In – too much freedom for the students to do and done senior year, do we need to introduce it earlier in curriculum?
 - Michele – at first, mentioned that this is how it works in real world and will have to do it regardless
 - At other institutions, introduced open-ended problems their freshman year
 - Dan – have freshman, sophomore, and junior classes, and set them up with scaffolding but with most open-ended problems in their junior year- you have to build it but still may get differential responses
 - Michele – minimize pushback by providing sample exams
 - Tyler – pushback stopped by using alternative grading such as specifications grading approaches to reduce the pressure which allowed students to embrace ownership of problem more, teach design and say it doesn't matter what you make as long as you go through the process and document it properly
 - Teaches sports biomechanics and will make it all projects with specifications grading only
 - To do final grade – series of projects of different levels of intensity so you do set of projects for a C, all plus extra set for a B, and do everything get an A, get feedback along way
 - Hard to make leap and get students on board, and by doing bucket is good way of motivating them and not have them complain as much
- What is Jupiter notebook?
 - Platform independent lab notebook
 - <https://jupyter.org/>
 - Can include code and notes, can use as a living textbook
 - Dan – uses Google CodeLab - <https://codelabs.developers.google.com/>