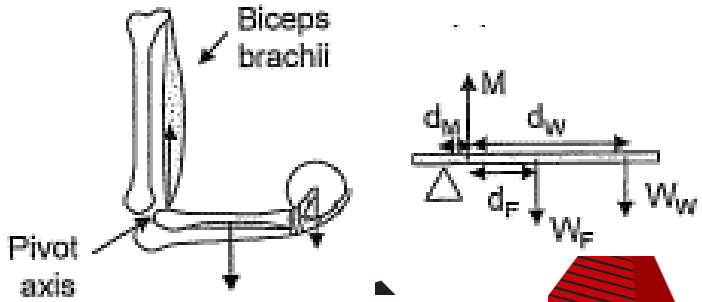
Using MATLAB in a Flipped Undergrad Biomechanics Class

Christa Wille, PT, DPT
Biomedical Engineering
University of Wisconsin-Madison

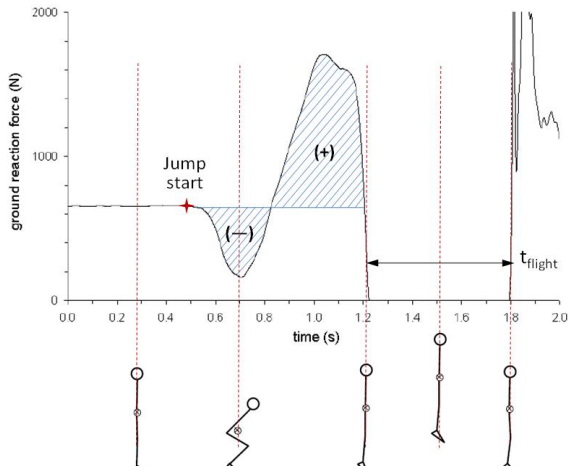
Our Class: Biomechanics

- Core departmental course
- 80-100 Undergraduates
- Varying degree of MATLAB experience

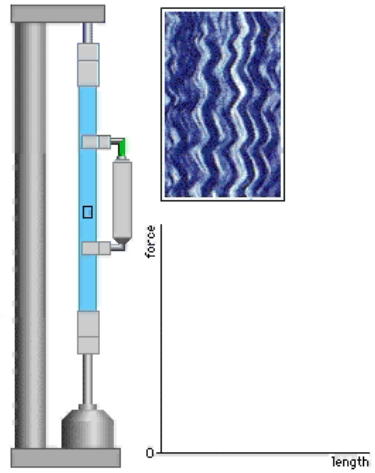
- Analyze human movement using basic principles of engineering mechanics as tools for discovery and understanding



Biostatics



Biodynamics



Tissue Biomechanics

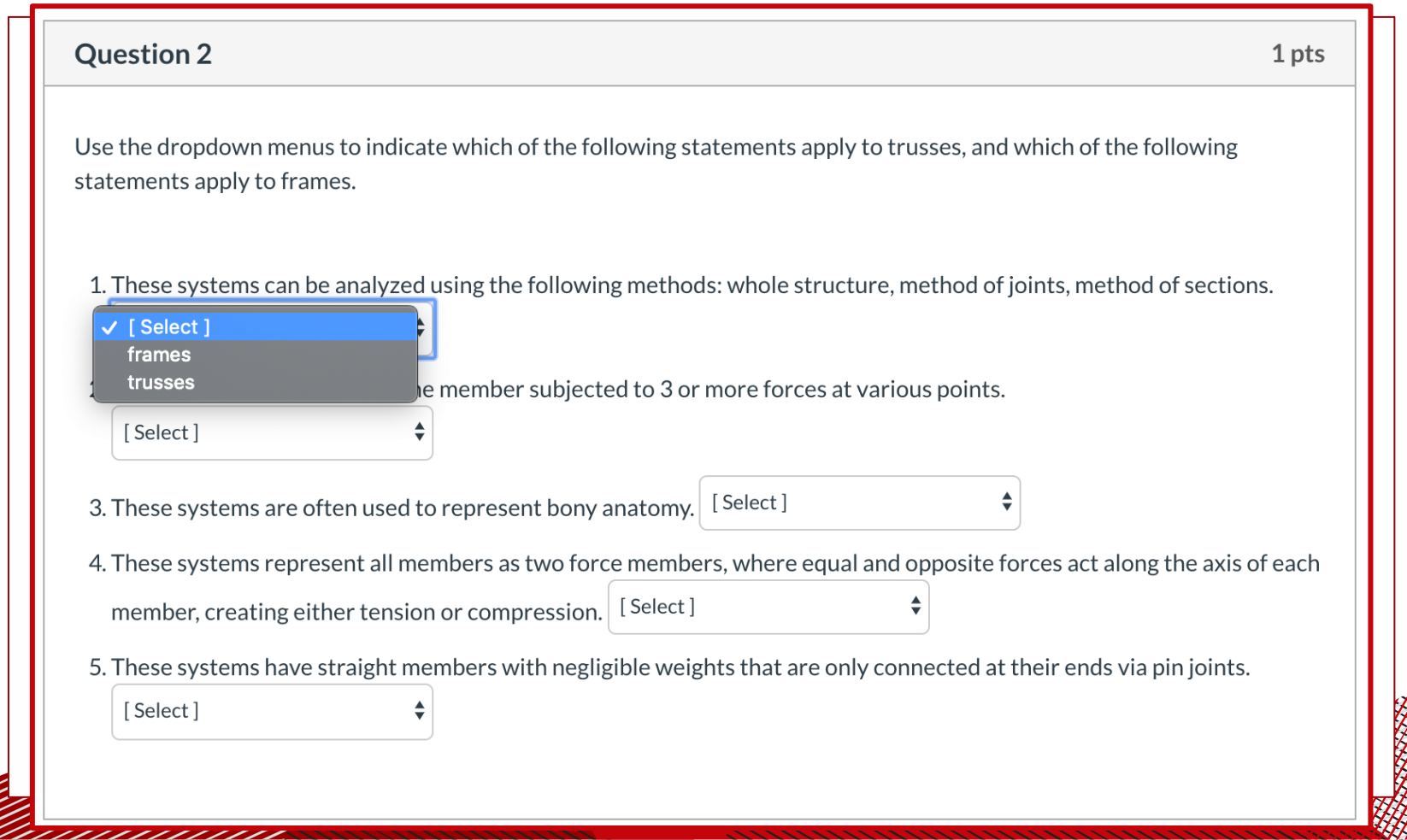
Flipped Classroom

- Pedagogical model with traditional lecture and practice components reversed
- Face-to-face classroom time utilized for interactive group problems solving and discussion of difficult concepts
- Need for engineering graduates to be able to solve real-world problems and work in teams

Walvoord et al. (1998) *SF: Jossey-Bass*
Lage et al. (2000) *J Econ Educ*

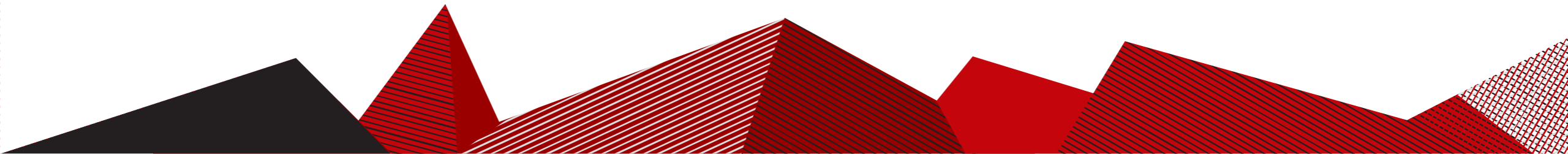
Course Structure

- Online lectures
  - 10-15 min content based lectures



Course Structure

- Online lectures
  - 10-15 min content based lectures
- In-Class Time
  - Active learning



In-Class Time: ACL Example

- You are testing ACL reconstructions with an orthopedic surgeon. You record the following load-deformation data for an experimental ACL reconstruction in an animal model. The harvested reconstructions were tested in tension until the ligament reached failure. The AVL cross-sectional area was 126 mm^2 and the bone-to-bone resting length of the ligament was 29.5mm. Plot the stress strain curve and de mechanical properties listed below.
  - Young's Modulus
  - Yield Strength
  - Ultimate Strength
  - Rupture Strength

Displacement (mm)	Load (N)
0.00	0
0.01	0
0.02	10
0.03	37
0.04	96
⋮	⋮

Course Structure

- Online lectures
  - 10-15 min content based lectures
- In-Class Time
  - Active learning
- Homework

Question 4 5 pts

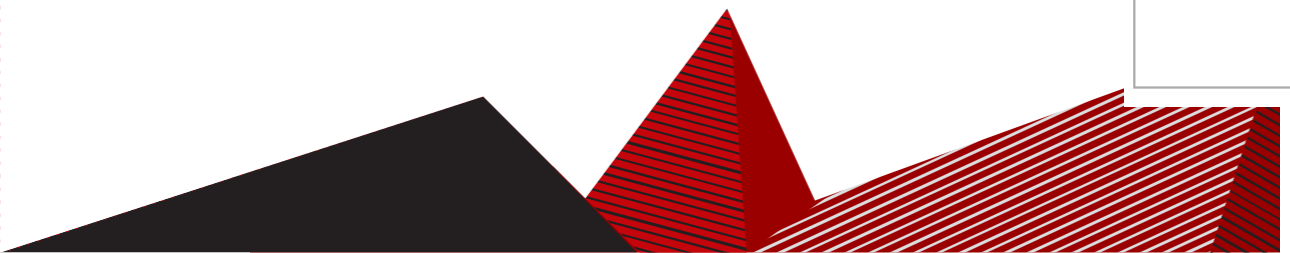
Determine the area of the force plate if it is known that at an instant in time a subject steps on the plate at location (-1.13 m, -0.77 m), and the readings of the 4 load cells are such that their x and y components are zero and their z components are as follows: F_{1z} = 245 N, F_{2z} = 143 N, F_{3z} = 299 N, F_{4z} = 204 N. Assume that the load cells are located at the corners of the force place. You cannot assume that the force plate is square. Enter your answer in units of square meters.

Note: Do not be alarmed if you get large area values!

Question 10 0 pts

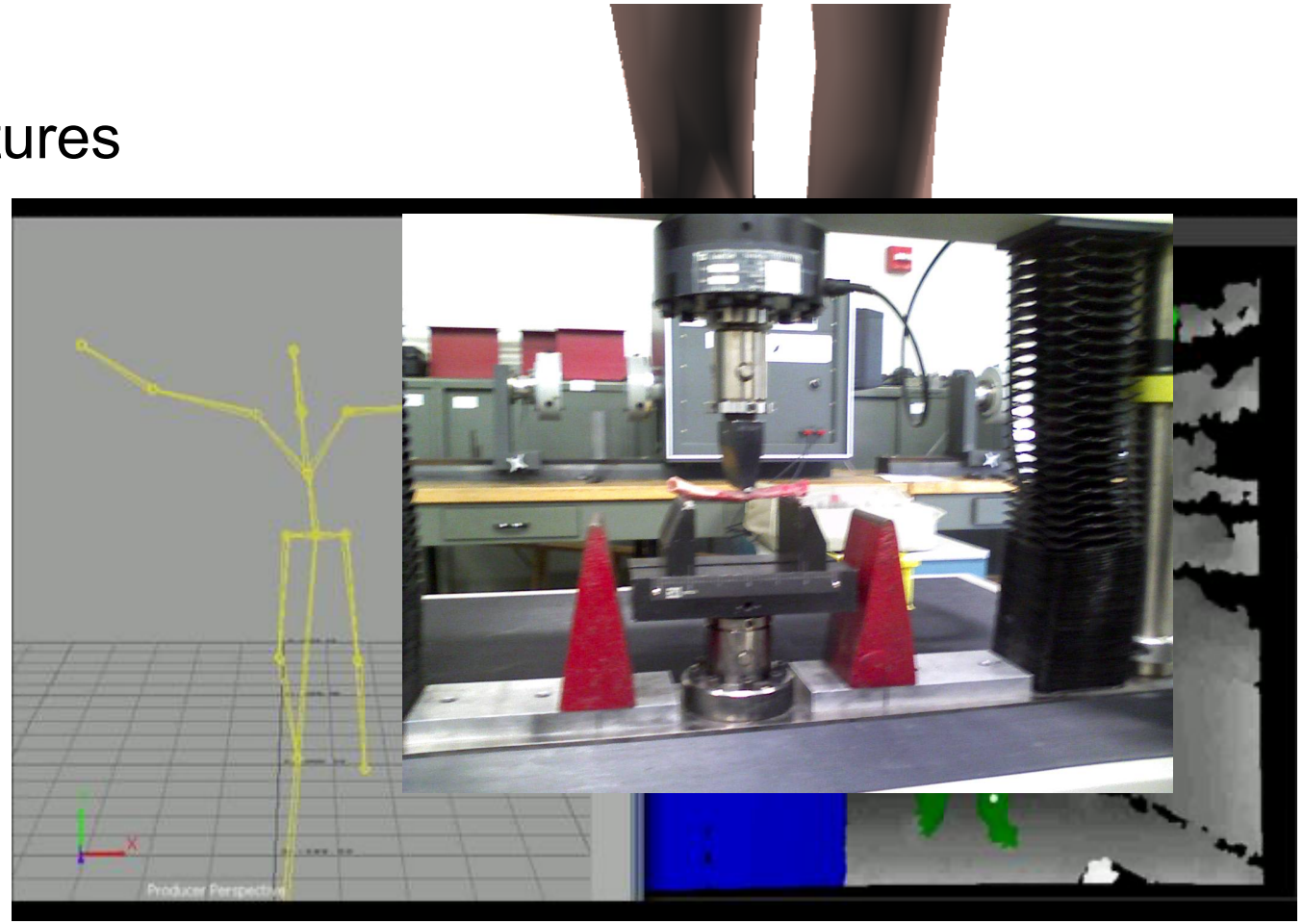
Please attach scanned documentation of your work.

Upload Choose a File



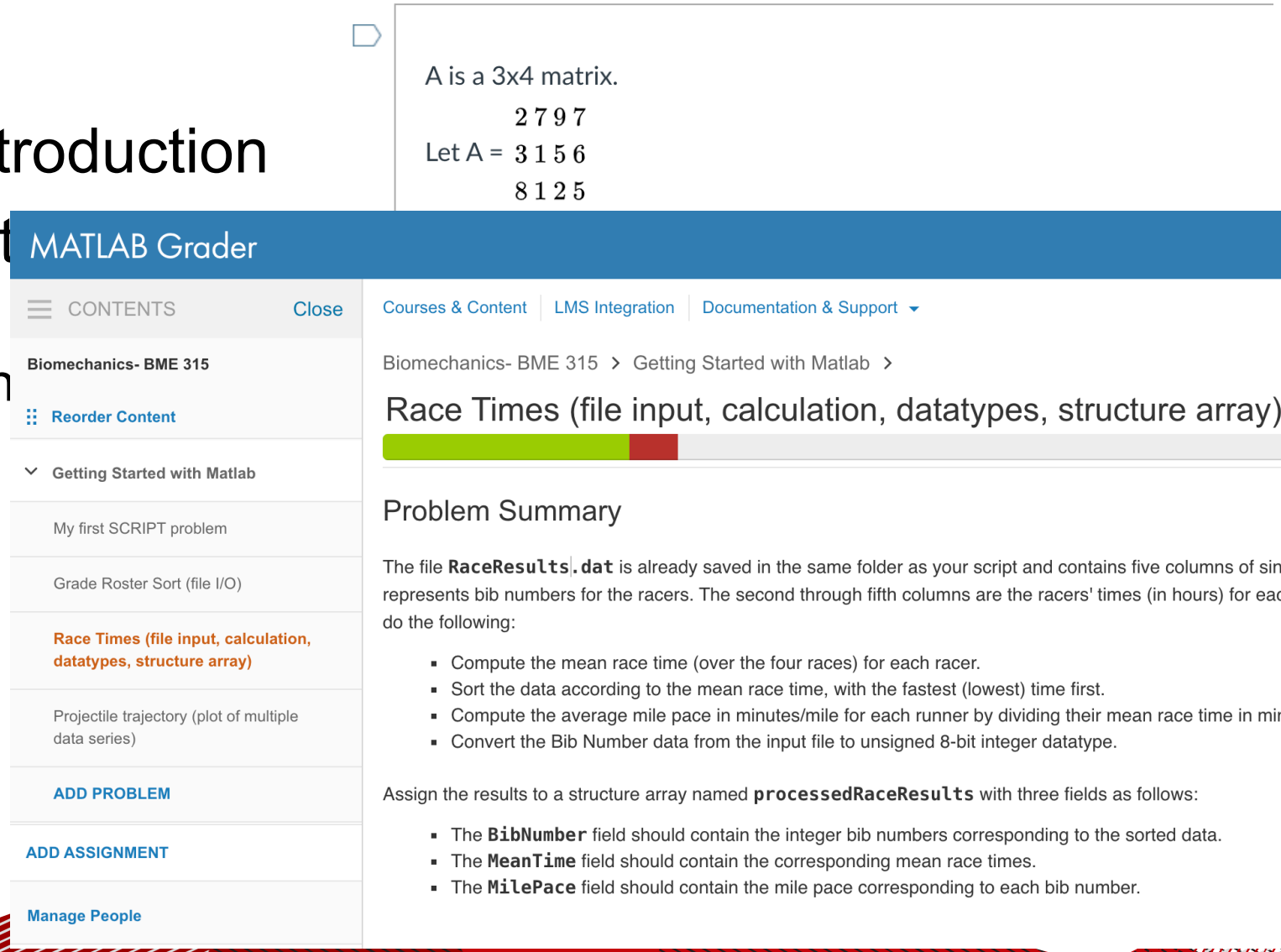
Course Structure

- Online lectures
  - 10-15 min content based lectures
- In-Class Time
  - Active learning
- Homework
- Laboratory sessions
- Exams



Teaching MATLAB

- MATLAB Onramp
- MATLAB Grader for introduction
- Homework assignment completed on LMS
  - Analysis in MATLAB an answers in LMS
  - Upload



Teaching MATLAB

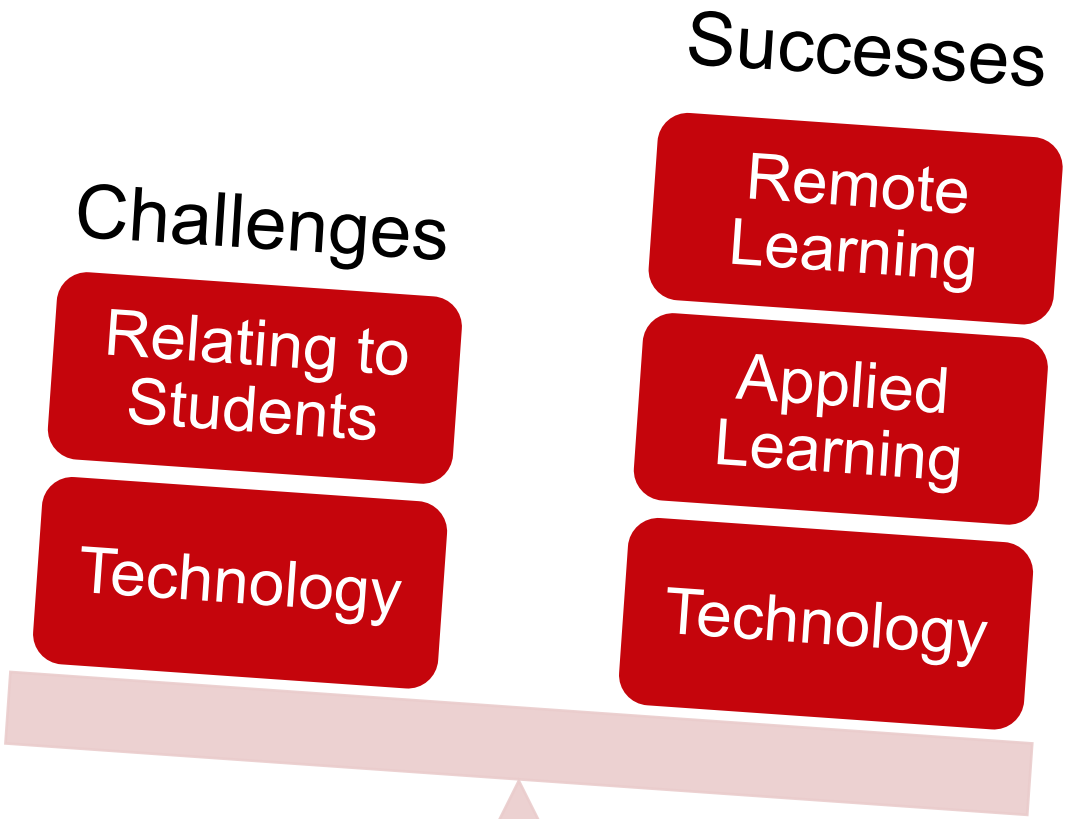
- Data analysis in lab setting

```
% Plot your raw data and inspect it to make sure it looks as you expect
figure;
plot(force);

% Record the first and last frame of the linear region of the loading
curve
% Enter the gauge length and cross-sectional area for the specimen
j1=input('Enter first frame of the linear region of loading curve');
j2=input('Enter last frame of the linear region of the loading curve');
Lo=input('Enter the gauge length');
A=input('Enter the cross-sectional area of your specimen');

% Calculate tendon stress and strain, being careful to use consistent
units.
stress=…
strain=…

% Plot tendon stress and strain, being careful to use consistent units
```

Conclusion

- Success of course model
  - Remote learning
  - Applied examples
  - Self paced learning
  - Professional development

- Future Work
  - MATLAB problems in an exam
  - Continue to build MATLAB grader questions



Thank You!

Christa Wille, PT, DPT
cmwille@wisc.edu