2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #32483

Applying the Framework of Fink's Taxonomy to the Design of a Holistic Culminating Assessment of Student Learning in Biomedical Engineering

Dr. Emily Dosmar, Rose-Hulman Institute of Technology

B.S. Biomedical Engineering, Rose-Hulman Institute of Technology Ph.D. Biomedical Engineering, Illinois Institute of Technology Assistant Professor of Biomedical Engineering, Rose-Hulman Institute of Technology

Dr. B. Audrey Nguyen, The University of Akron

B.S. Biomedical Engineering, The Ohio State University M.S. Biomedical Engineering, The Ohio State University Ph.D. Biomedical Engineering, The Ohio State University

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Abstract

A cohort of junior biomedical engineering students concurrently enrolled in Biomechanics, Biomaterials, and an associated lab class (BME Labs) were assigned a comprehensive, fully immersive final project in lieu of final exams. In a typical quarter, Biomechanics and Biomaterials culminate in a traditional 2-4 hour final exam, while BME Labs terminates in a condensed 2-week design mini-project. This integrated final project was motivated by student feedback regarding their workload during the final weeks of the quarter, and aimed to focus their efforts towards a single deliverable while addressing student outcomes and learning objectives (SLOs) from all three courses.

In designing summative assessments of student learning, a traditional course often implements a final examination with questions built to evaluate SLOs that employ illustrative verbs from Bloom's taxonomy. While useful, Bloom's taxonomy provides an "incomplete framework for articulating measurable SLOs" and instructors must consider "the context of the SLOs... to describe expectations for self-directed learning, immersion in the primary literature, [and] engagement in professional practice" (Stanny, 2016). One such framework to address the insufficiencies in Bloom's taxonomy is Fink's Taxonomy of Significant Learning. Instead of higher levels of learning described as a sequence built upon foundational knowledge, Fink's taxonomy considers foundational knowledge to be as important a component of "significant learning" in conjunction with application, integration, the human dimension, caring, and metacognition - or "learning how to learn" (Fink 2003). Our goal was to design a holistic culminating project that would be used to evaluate SLOs from all 3 courses.

Students worked in groups to design and execute a set of experiments of their choosing. The project was intentionally open-ended to encourage selection of topics that were of interest to the students and address the "caring" element from Fink's. They were expected to submit an extensive biomechanics and biomaterials literature review as well as a biomechanics model. The students worked in groups of 3-5 and were given several weeks and several days of class and lab time to dedicate towards making progress. Students were encouraged to match their empirical data to their mathematical models and draw conclusions about the shortcomings of each. The final deliverable consisted of: abstract, background and significance, biomechanical model, biomechanical and biomaterials analysis, design of experiment and data collection, results and analysis, discussion, future directions and recommendations. This deliverable evaluated students' learning in all 6 elements of Fink's taxonomy, particularly focusing on the elements of application, integration, and the human dimension.

Student course evaluations for biomaterials and BME Labs were tracked over four years and compared in terms of student identified “overall learning”, “overall course”, and “overall professor performance”. The student ratings for all three of these categories was highest in the 2019-2020 final project year for Biomaterials with scores of 4.23, 4.21, and 4.66 respectively as compared to second highest scores of 4.15, 4.16, and 4.41, respectively (1.9%, 1.9%, and 5.5% difference, respectively). For BME Labs, the 2019-2020 final project year ranked highest in the category of “overall professor performance” (4.6, 1.7% increase) and second highest in the categories of “overall learning” and “overall course” with scores 4.31 (4.5% decrease) and 4.08 (10% decrease), respectively. Qualitative feedback on the project was also collected on the student course evaluations. Themes discussed regarding the final project included needing more time, more detailed rubrics, and more specific instructions/feedback; however, the general sentiment regarding the projects was positive.

Many of the projects were creative in a way we could not have imagined. Students got a taste of what research is like and got to see an intersection of research, modeling, and design. The variety and the complexity of projects was incredible, and ranged from synthesis of a hydrogel replacement for articular cartilage to implementation of a peristaltic pump in drug delivery systems to design of an improved bandage for post-knee surgery. In some cases, it was difficult to distinguish the quality of the student deliverable from that of an undergraduate or master’s research thesis.

With this project students were able to focus their efforts in a single direction while still incorporating concepts from their three discrete courses, thus reducing the end-of-term workload. Student perceptions of their learning experience were as good and in some cases better than those from previous instances of these courses with traditional final assessments. Anecdotally, the outcomes far exceeded that of a traditional final exam.

Background

In designing summative assessments of student learning, a traditional course often implements a final examination with questions built to evaluate student learning objectives (SLOs), both of which employ illustrative verbs from Bloom’s taxonomy as shown below in Figure 1. For example, to assess student comprehension of solid modeling of viscoelastic materials, students might be asked to compare and contrast between Kelvin-Voigt and Maxwell models; “compare” and “contrast” are the verbs derived from Bloom’s taxonomy at the level of “analyze”.

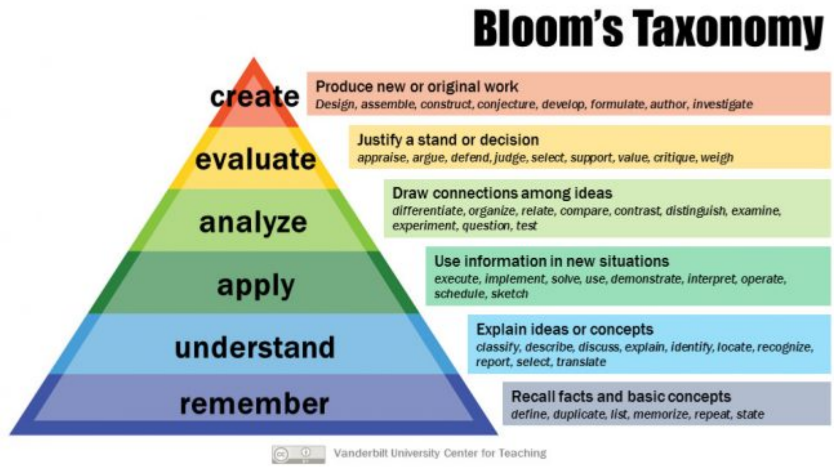

Figure 1: Bloom's Taxonomy of a framework for evaluating student learning with example active verbs for developing student learning objectives. (Vanderbilt University Center for Teaching)

While it is a useful framework, Bloom's taxonomy does not explicitly consider the concepts of self-directed learning, engagement in professional communities, and other human-centered concepts. Outcomes are limited in their ability to define clear and measurable SLO's and instructors must consider how the SLO's fit into the broader field and how the student is capable of life long learning. (Stanny, 2016). As an instructor seeks to identify important SLO's rooted in Bloom's Taxonomy, they will often find it difficult to address the top levels of the pyramid, primarily the "create" category in a meaningful way within the confines of a quarter or semester course. This is particularly true on timed assessments and in a traditional exam structure.

One such framework to address the insufficiencies in Bloom's taxonomy is Fink's Taxonomy of Significant Learning (Figure 2) . Instead of higher levels of learning described as a sequence built upon foundational knowledge, Fink's taxonomy is highly integrative and considers foundational knowledge to be as important a component of "significant learning" in conjunction with application, integration, the human dimension, caring, and metacognition - or "learning how to learn" (Fink 2003). Fink's Taxonomy is nonlinear in structure and promotes overlap between the myriad ways of demonstrating knowledge.

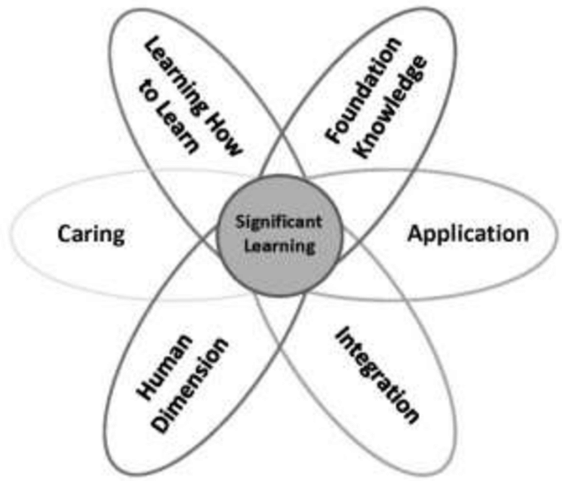

Figure 2: Fink's Taxonomy of Significant Learning (Fink 2013).

An additional limitation to current college curricula is the finite bounds that differentiate courses. Students often incorrectly view the end of one class as the end of that topic and fail to see how knowledge, concepts, and skills transcend courses and even disciplines. Renato Rodrigez extols the benefits of blurring the lines between course concepts and courses themselves to promote knowledge retention, development of professional skills, leadership, and communication. (Rodriguez, CEEA Proceedings 2019). It is his view as well as ours, that overlapping between courses illustrates for students the relevance and interconnectedness of the content that they are learning. Borrowing from these ideas of holistic, non-linear education, our goal was to design a culminating project that would be used to evaluate SLOs from a cohort of junior biomedical engineering students concurrently enrolled in 3 courses: Biomechanics, Biomaterials, and an associated labs class (BME Labs). Instead of basing the SLO's for this assignment in the traditional Bloom structure, we applied the Fink model and encouraged students to take risks and to step outside the bounds of their knowledge when completing this project. By creating a single final project for all three courses, we explicitly apply Fink's integrative taxonomy and ask students to apply and integrate the material from all courses to create an original experimental design and model. It was our expectation that student learning would be maximized in this project where there is a strong emphasis on integration of content across multiple courses and incorporating the human dimension and motivation behind their projects - far beyond what would be assessed with traditional final examination for each discrete course. Furthermore, we expected the students to demonstrate creativity, agency for learning, and anticipated that they would hold this experience in higher value as compared to a traditional final exam.

Methods

Final Project Description

A cohort of junior biomedical engineering students were concurrently enrolled in Biomechanics, Biomaterials, and (BME Labs) during the winter quarter 2019-2020 (pre-COVID-19). These students received traditional lectures, homework, quizzes, and exams throughout each of the three distinct courses and each course was treated as its own discrete structure. At the end of the term, instead of traditional final exams, students were assigned a comprehensive, fully immersive final project that addressed themes from all three of the courses. This project was worth 20% of the final grade in each of the respective courses and students worked in groups of 3-5 members. The project assignment is available in Appendix A. In short, the students were asked to propose a new or alternative biomedical device or implant of their choosing. This device must serve a specific purpose and must require data that can be acquired in the lab. At a minimum, the students had to: 1) perform a biomechanics analysis, 2) write a biomaterials literature review, 3) describe an experimental hypothesis, 4) design an experiment or set of experiments to evaluate their hypothesis, and 5) to collect and analyze their data and make recommendations regarding their biomedical device. Each of these elements was mapped to one or more objectives from Fink's Taxonomy. Additionally, final exams previously assigned in each of these courses were also mapped to the relevant objectives from Fink's Taxonomy (Table 1). Students were given approximately 6 weeks to complete this project; students were expected to work on their final project concurrently with normal weekly labs and class assignments. The final projects were then coded for specific skills and knowledge.

Table 1: Deliverables required for final project mapped to the relevant Fink's Taxonomy objectives and coded for whether explicitly or implicitly assessed

Deliverable	Finks Taxonomy					
	Learning how to learn	Foundational knowledge	Application	Integration	Human Dimension	Caring
Traditional Exam		Pink	Pink		Blue	
Background and significance	Blue	Blue	Blue	Blue	Pink	Pink
Literature Review	Blue	Blue	Blue		Blue	
Biomechanics Analysis		Pink	Blue		Blue	
Experimental Design	Pink	Blue	Pink	Pink		
Biomaterials Analysis		Pink	Blue			
Data Collection		Blue	Pink			
Statistical Analaysis		Blue	Pink			
Discussion	Blue	Blue	Blue	Pink	Pink	Pink
Implicit = Blue	Blue					
Explicit = Pink	Pink					

Student Feedback

In the final week of the course, students submitted anonymous course evaluations for each class and the professor(s) associated with them. They evaluated the courses on the following criteria: Overall learning, Overall Course, and Overall professor performance on a Likert scale from 1-5 (where 1=poor and 5=excellent) and asked to comment specifically on the final project described above. These numerical scores were compared to the scores from the same courses taught in previous years by the same professor for BE labs and Biomaterials. The scores for Biomechanics were not available for any of the years.

Results

Final Project Summary

The 9 student projects are summarized below in Table 2. Students rose to the challenge of this new project and generated projects that covered a wide range of topics while still addressing the SLOs in all three classes. The objectives from Biomechanics were addressed as part of their Biomechanical Analysis and Model, those from Biomaterials were addressed as part of their experimental design or their literature review, and the objectives for BME Labs were addressed in their experimental design and final documentation. 67% (6/9) of projects utilized traditional mechanical testing, 44% (4/9) included motion capture, 44% employed a force plate and/or dynamometer, 44% included physical biomaterials that were either synthesized or extracted for analysis, 11% (1) generated a finite-element (FEM) simulation of a dynamic flow chamber, and 100% included statistical testing and literature review.

Table 2: Summary of the physical tests completed, biomechanics models, and biomaterials investigated in each of the 9 student projects

Project Title	Physical tests completed							Biomechanics Model			Biomaterials		
	Tensile/compression testing	Fatigue/Cyclic/hysteresis	Dynamometer	Motion Capture	Force plate	Flow	Staticisal Testing	Mass-spring Damper	FBDs	FEM	Biological	Synesized	Analysis
A better post-knee surgery bandage	■	■		■			■	■					■
Evaluation of Volleyball Kneepad Performance in Defensive Lunge Motion	■	■		■	■		■		■				■
Amputee Simulation While Riding a Stationary Bike: Biomechanical Analysis of Dynamometer and Motion Capture			■	■			■		■				■
A characterization of fluid flow and gelation in influences on drug delivery in alginate hydrogels						■	■			■		■	
Hydrogels as a Potential Anti-Inflammatory Drug Delivery System Targeted to Osteoarthritic Knees		■			■		■		■			■	■
The Effects of Knee Bracing on Knee Biomechanics & a biomaterial analysis of current braces		■		■			■		■				■
Anterior Cruciate Ligament Replacement: Evaluation of the Mechanical Properties of Polyester after exposure to NSAIDs	■						■	■			■	■	■
Examining shoe soles to allow for maximum stability					■		■	■					■
Porcine ligament xenografts for ACL replacements	■						■	■			■		
Total	4	4	1	4	3		9	4	4	1	2	3	7

To visualize the open-endedness and creativity that was embraced by the students in this project, a word cloud was generated from the projects using TagCloud and is shown below in Figure 3. The abstract or executive summary for all projects were entered into the word cloud generator (TagCloud) to visualize the frequency of certain words in the students' final documentation for all 9 student groups. Words that appear more frequently will have a correspondingly large font size, where words that appear less frequently will appear with a smaller text in the figure.

Figure 3: Word cloud generated from students' final project abstracts and executive summaries. Frequency of words directly corresponds to the size of the word in the figure.

The word cloud reveals that the students' final projects were incredibly varied and creative in their experimental design. Though the 9 group projects covered a wide range of topics, terms that were seen across their final documentation included key phrases such as: "cross-linking", "density", "energy", "forces", "loading", "material", "patients", "properties", "prosthetic", "strength", "tensile", and "testing".

Student Feedback

Student course evaluations for biomaterials and BME Labs were tracked over four years and compared in terms of student identified "Overall Learning", "Overall Course", and "Overall Professor Performance" (Figure 4). The student ratings for all three of these categories was highest in the 2019-2020 final project year for Biomaterials with scores of 4.23, 4.21, and 4.66 respectively as compared to second highest scores of 4.15, 4.16, and 4.41, respectively (1.9%, 1.9%, and 5.5% difference, respectively). For BME Labs, the 2019-2020 final project year ranked highest in the category of "overall professor performance" (4.6, 1.7% increase) and second highest in the categories of "Overall Learning" and "Overall Course" with scores 4.31 (4.5% decrease) and 4.08 (10% decrease), respectively. Qualitative feedback on the project was also collected on the student course evaluations. Themes discussed regarding the final project included needing more time, more detailed rubrics, and more specific instructions/feedback; however, the general sentiment regarding the projects was positive.

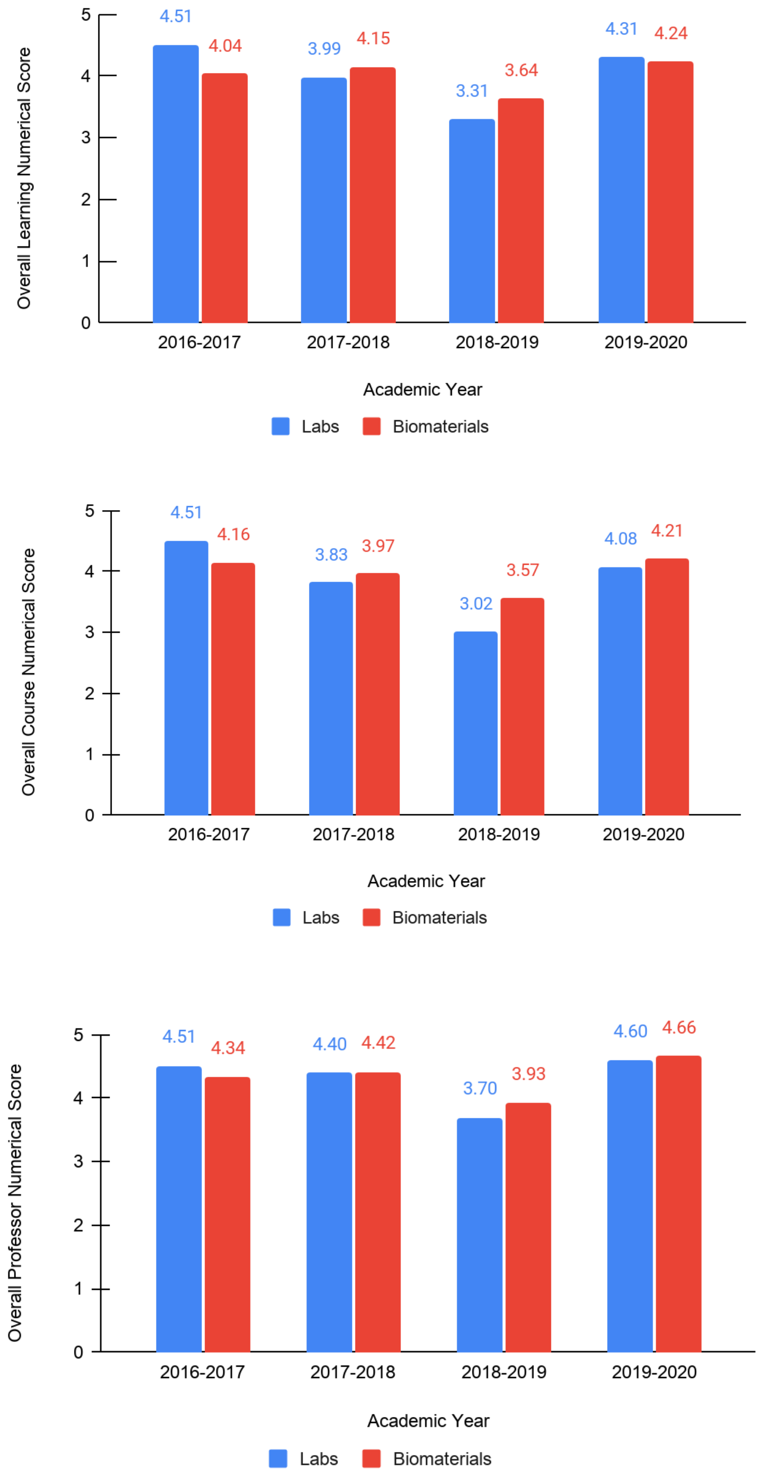

Figure 4. The numerical scores on a Likert scale from 1-5 (where, 1=poor and 5=excellent) for (Top) Overall learning, (Middle) Overall course, and (Bottom) Overall professor for the BE labs and Biomaterials for academic years 2016-2017 to 2019-2020. These courses were all taught by the same professor. Student feedback was anonymous and provided in the final week of the

quarter before final grades were assigned. Students in the 2019-2020 cohort completed the combined final project.

Discussion

The projects that resulted from this assignment were outstanding. As outlined by the expectations, all projects included multiple physical tests; however, these expectations were exceeded in many instances where students synthesized or harvested their own materials or built their own testing conditions. 100% of the projects included statistical testing and literature review (Table 2). Among the most frequently occurring words depicted in the word cloud (Figure 3) were: “hydrogel”, “testing”, “study”, “cross-linking”, “hysteresis”, “tensile”, and “forces”. These, along with the other words shown, suggest the ability of the students to use vocabulary appropriate for this application. The top 75 words that were used to generate the word cloud were largely of a technical nature or those that would suggest the description of an experiment. The caliber of the projects submitted in many instances were on the graduate school level and one project has been continued as an independent project, was published as a manuscript and presentation at the Rocky Mountain Bioengineering Symposium. A traditional final exam for each individual course following Bloom’s taxonomy for evaluating SLO’s could conceivably only assess students to the level of “evaluate”. These same final exams mapped to Fink’s taxonomy, only addressed 50% of the outcomes (3/6). This final project, however, blurred the lines between multiple courses allowing for instructors to assess students at all levels of Bloom’s taxonomy including “create”, but also to assess them on Fink’s taxonomy against the “human dimension”, “caring”, and “learning how to learn” elements. The work submitted demonstrated students’ ability to integrate their knowledge across multiple classes and disciplines, and in several cases, create new knowledge. The creativity and originally of the projects far exceeded what would be possible on a traditional exam.

The student evaluations for both Biomaterials and BME labs suggested that the students were not unhappy with a large project in place of exams despite the fact that the hours spent were likely in excess of what they would have spent studying for exams. Most notably, student ranking of their own learning was a full point higher than it had been in the previous year in BME labs and the highest that it had ever been in biomaterials with no significant changes beyond the final project (Figure 2). This is possibly due to the fact during traditional final exams, the assessment is purely summative; students either have or have not mastered the content in the assessment related to the course objectives. However, with this integrative and large-scale project, learning continues throughout the process. The professors involved in the experiment of eliminating final exams in favor of this large assignment found that the application of knowledge required for the successful completion of these projects required a level of understanding that would have been difficult to assess using a traditional exam structure.

Future directions and recommendations

One student suggestion that appeared multiple times was the desire for a clear rubric that outlined project expectations. The difficulty with this lies in the fact that each project was unique and we were concerned that a rubric would limit creativity. A potential solution to meet this request without sacrificing "open-endedness" would be to implement a very broad and general rubric similar to what might be used on a grant assessment with categories such as "goals and objectives", "intellectual merit", "implementation", and "evaluation". In this rubric, we can generate criteria that are directly linked to the categories described by Fink's taxonomy. For example, the biomechanical model component of the project would evaluate the students' mastery of the relevant foundational knowledge, and the literature review component would evaluate both caring and the human dimension.

We would also like to investigate the learning that occurs throughout the project execution. A low stakes "pre" and "post" assessment might be implemented to demonstrate the growth that students experience while completing such a lengthy and in depth assignment. The "post" assessment would also contribute towards the metacognition aspect of Fink's taxonomy, by explicitly illustrating to the students that learning has occurred. In the future, we would like to develop such an assessment that could eventually be used to justify more classrooms moving away from traditional assessment techniques.

Conclusion

Many of the projects were creative in a way we could not have imagined. Students got a taste of what academic and clinical research is like and got to see an intersection of research, modeling, and design. The variety and the complexity of projects was incredible, and ranged from synthesis of a hydrogel replacement for articular cartilage to implementation of a peristaltic pump in drug delivery systems to design of an improved bandage for post-knee surgery. In some cases, it was difficult to distinguish the quality of the student deliverable from that of an undergraduate or master's research thesis.

With this project students were able to focus their efforts in a single direction while still incorporating concepts from their three discrete courses, thus reducing the end-of-term workload. Student perceptions of their learning experience were as good, and in some cases better than, those from previous instances of these courses with traditional final assessments. Anecdotally, the outcomes far exceeded that of a traditional final exam. Fink's taxonomy is a more integrative framework of learning that is better suited for student learning outcomes for engineering disciplines than Bloom's taxonomy which implies a sequential framework of mastery that neglects the human element, caring, and metacognition aspects of significant learning.

Works Cited

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Appendix

<u>Combined Final Project</u>

Introduction

This final project will give you the opportunity to expand your knowledge in an area of biomedical engineering that interests you. We expect that you will remember what you have learned from this project well after the end of this quarter. This project will get you into the literature where you can see for yourself the results of biomechanics and biomaterials research and gain some experience extracting useful information from the literature to meet your own needs…a very useful skill in biomedical engineering! Additionally, you will collect experimental data to support your research.

Group Selection

You may work in teams of four. You may work with people in either lab section, however, you should make sure that everyone is present for data collection.

Goal

You work for a company where your boss has just given you an assignment of developing a new device. You need to submit a document to her to justify your plan and ideas for moving forward.

1. Propose a new or alternative biomedical device or implant of your choosing. This device must serve a specific purpose and must require data that can be acquired in our lab.

Some general categories of topics are:

- Orthopedics (hip, knee, etc.)

- Cartilage
- Tendon/ligaments

However, we are very open to your ideas so, go wild.

2. Perform a biomechanics analysis

3. Collect relevant data

4. Write a biomaterials literature review

Example project: Proposing a new running shoe for a sprinter that will minimize knee injury (knee reaction forces)

Parameters: Force generated through running and knee angle at impact

Biomechanics analysis of these parameters. This will include a list of assumptions, FBDs, hypothesis testing, and mechanical modeling. You should discuss how your experimental results compare to the underlying theory. You should reference primarily literature.

Data collection (2 parameters): Force generated through running and knee angle at impact. Compare your experimental results to your theoretical calculations.

Based on your collected data, conduct a biomaterial analysis of the components that will be selected for your shoe. What material properties are necessary? What materials fit your criterion? Use primary literature to justify your choices.

Recommendations for how to move forward with this project.

Biomechanics analysis

Conduct a preliminary biomechanics analysis of two parameters relevant to your chosen topic. Clearly state the goal of your biomechanics analysis, i.e. what are you investigating and why? (Note: a preliminary analysis is often conducted to determine whether or not the time and/or resources should be devoted to conducting a complete study. Focus your analysis on critical areas of interest.

You are encouraged to extract and analyze data from your selected journal articles and confirm that they are reasonable. If all the necessary information is not available, please state your assumptions and justifications for these assumptions in your project submission.

Project submissions should clearly state the goals of the analysis and describe the process used to conduct the biomechanics analysis. All submissions must include free body diagrams, model inputs, calculations/equations used, results, and conclusions/discussion.

Data Collection

Select two parameters that you would like to measure to verify the biomechanics analysis that you performed in the previous section. You should include the following components in your final document:

Introduction:

Include a brief description of each of the experiment you conducted and the rationale for the experiment. Find (at least) one relevant/related research article to cite to support your decisions. Be sure to discuss the hypotheses tested. This section should articulate the questions that you are trying to answer in this lab.

- A summary of the objective of the experiment and a brief discussion of the rationale behind the experiment (i.e. why is this question interesting or relevant?).
- A description of the measurements to be taken and a rationale for each measurement.
- A hypothesis that can be quantitatively tested for each measurement to be taken.
- The number of subjects to be tested (a target of 6-8 subjects is recommended) and the selection process used to identify the subjects.
- A detailed testing protocol, which should include:
  - experimental set-up requirements (i.e. required equipment, "garment" instructions to the subjects, number and location of subject markers, description of testing instructions (i.e. the "script" given to each subject, duration of data collection, number of repeated trials, etc.),
  - the type and frequency of measurements to be taken.
- A description of how the measurements will be extracted from the motion capture software (or other equipment used)
- A description of the analysis that will be performed at the end of the experiment to test the hypotheses (i.e. statistical analysis) and why that analysis is appropriate.

Methods:

- Include a clear, brief description of the experiment, include relevant demographic statistics for your participants (i.e. number of subjects, gender stats, age stats, height stats, etc.)Provide enough procedural detail so that your experiment could be replicated by someone with a technical background in another laboratory. Specify the equipment/settings used.
- Provide a clear statement of the measured outcomes for the experiment. In other words, what parameters will be used to answer the questions outlined in the introduction?
- Explain the statistical analyses conducted.

Results:

- Include separate sections with subheadings that correspond to the measured outcomes for the experiment.
- Include graphical and tabular representation of results. Combine plots and tables when it makes sense to do so (even in the appendix). Strive for clarity, and make it easy for the reader to draw the relevant conclusions from your data (keep in mind what the questions were).
- Show one representative result for each of the measured outcomes, and then include the results for each subject in tabular form. The complete results for other subjects can be included in an appendix.
- Show sample calculations, as relevant to your experiment.
- For each experiment, statistically evaluate your findings and clearly present the results of the statistical analyses. Include Minitab output in the Appendix.

Discussion: Include separate sections with subheadings to discuss the implication of the results (i.e. interpret the data). Address potential sources of error in the experiments.

Biomaterials analysis

Write a biomaterials analysis of your topic. Describe the relevant types of materials used for the given application. Why are these materials chosen and what properties are important? What kind of experiments are important? What is the interface when this material is put into the body and how does the body interact with it? How do your results from the previous two sections help to inform your material selection? It is likely that you will want to consult a review article about this topic when writing this section. Reference primary literature in your discussion.

Presentation

What's the point of doing a massive project if you don't get to share it? During 10^{th} week, you will pitch your idea and update your bosses (us) on what you have accomplished so far. These presentations will not be on the completed project (because you might not have finished yet) but should be something like a business pitch and will an opportunity for you to get feedback on your ideas and progress. Presentations will be during pre-lab lecture 10^{th} week.

Timeline and check-ins

The following dates are intended to keep you on track to finish the project without waiting until the last minute.

Topic selection – End of 5^{th} week

Proposal draft and meet with Drs. Dosmar and Nguyen to finalize project details– End of 6th week

Preliminary biomechanics analysis–End of 7th week

Primarily biomaterial analysis – End of 8th week

Begin data collection – Beginning of 9th week

Continue data collection - 10th week

Presentation – 10th week

Final draft – Friday of 10th week at 5pm

General Expectations

This project is worth 20% of your final grade in Biomaterials, 20% of your grade in Biomechanics, and 100 points towards the "lab reports" category of your BE labs grade. You should not start this project the night before. It should take significant effort and thought on your part. It is expected that you submit a well-researched, carefully crafted project. It is likely (and expected) that you will use several sources to complete your topic. In text citations and a works cited section are expected. Your project should be typed and professionally formatted with a cover page, table of contents, page numbers, and works cited section.

Sections

At a minimum, your report should include the following sections:

Cover page

Table of contents

Abstract

Background significance

Biomechanical modeling

Data collection and experimental results

A discussion of how well your model matches your experimental results and what outstanding questions remain

Biomaterials discussion

Future directions and recommendations

Works cited

Appendices

Deadline

This project is due on the Monday of finals week at 8am to the Dropbox on Moodle in pdf format. You file should be named as the last names of your group members.