

## **Online Modules to Develop Upper-classmen Mentors for a First-Year Biomedical Engineering Course**

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**Work In Progress: Online Modules to Develop Upper-classmen Mentors for  
an Introductory Biomedical Engineering Course**

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## Introduction

The “Biomedical Engineering and Design” (BMED) course for undergraduate first-year biomedical engineering (BME) students at Johns Hopkins University is scaffolded by upperclassmen mentors, or “lab managers” (LMs). BMED consists of in-person lectures and weekly laboratory sections to expose first-year students to various topics in BME, introducing the core principles of engineering, design, and health inequity. At the beginning of the semester, the BMED students (n = 126) are randomized and placed into groups of five students. Each group is assigned to an LM enrolled in the Effective Teaching and Management of Engineering Teams course. As the BMED course continues, these LMs are crucial in guiding their first-year BME teams through engineering and design modules such as the Cardiovascular System, Arduino, Ethics, and Health Inequity Project. Since BMED follows a group-based, flipped, active-learning mode of engineering education, the LMs are vital in mentoring the BMED students. From survey results of previous years, LMs required skills in conflict management, assessment design, ethics, group development, peer review, public speaking, and technical communication to support BMED students successfully. Principles such as group design, peer review, and group development were included to promote core collaboration and cooperation skills between first-year BME students. Also, soft skills such as public speaking, engineering ethics, and technical communication were provided to support LMs in their own key development as biomedical engineers. Park et al. [1] corroborated positive association between non-technical professional skills, such as effective communication and teamwork, and engineering leadership self-efficacy, essential for effective leadership. After the BMED course, many LMs become teaching assistants and these skills are foundational in developing them as successful leaders. Our hope is that by testing the efficacy of these leadership modules below in **Table 1**, we can inform the instructional practice of the mentorship course and in general, how other first-year engineering educators can improve the development of student mentors.

Leadership Module	Justification
Conflict Management	LMs utilize their leadership skills in conflict management since they are the first line responders to group conflicts. Conflict management is an essential skill in group work, as project managers spend a minimum of 20% of their time dealing with conflicts [2].
Design of Assessments	Design of assessments is an important skill, as LMs help facilitate student learning and understanding this skill is important to promote student learning [3]. We also noticed that in general LMs were asked frequently by students for how best to study and prepare for exams.
Peer Review	Our peer review module was rooted in how peer evaluation and feedback could teach group members to provide constructive criticism to each other and overall improve their team skills. This has been found to play an important role in group development and serve them throughout their professional careers [4].
Group Development	LMs promote group development through following psychologist Bruce Tuckman’s model of group development, which emphasizes the transition of groups through the stages of forming, storming, norming, performing, and adjourning [5]. These stages emphasize the various periods of conflict and support that freshmen BME students will undergo throughout their time in BMED.
Ethics	Ethics is also an essential tool for engineers as students will need to not only solve biological problems, but also avoid side effects and thus “every single biomedical and biosystem engineering innovation must incorporate ethics [6]”

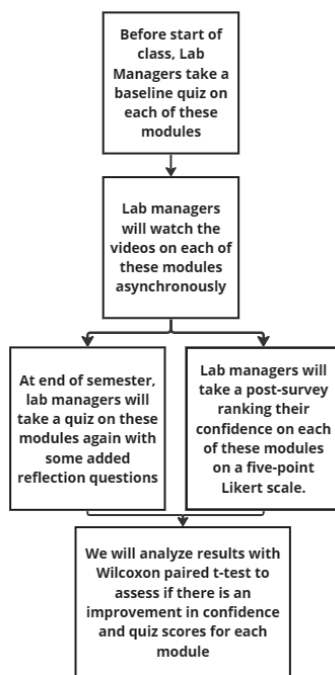
Technical Communication	Technical communication emphasized understanding one’s audience, communicating ethical considerations, and accessibility[7]. Technical communication is an important skill for the LMs and first-year students, as it has been found to guide students through the “planning, drafting, and design of documents that will matter in their professional lives [8].”
Public Speaking	Public speaking focused on how students and LM can best prepare for oral presentations and what strategies one could use to become a better speaker[9].

**Table 1: Leadership modules provided to LMs and their justifications.**

### Project Approach

We plan to conduct a single-site study at the Johns Hopkins University (JHU) in Baltimore, Maryland and approved by the JHU Institutional Review Board (**HIRB00018974**). Informed written consent/assent will be obtained from each research participant and/or parent if under 18 years old.

We created three to five-minute videos on leadership module: conflict management, assessment design, ethics, group development, peer review, public speaking, and technical communication. LMs must watch these videos to enroll in the LM course. LMs are given a baseline quiz to assess their understanding of the modules prior to watching the videos (**Fig 1**).



**Figure 1: Efficacy testing plan with the progression of the semester.**

The quiz consists of multiple-choice questions randomly pulled from a bank of questions in Canvas (**Fig 1**). Each LM (n=30) will complete this quiz asynchronously and untimed. At the end of the semester, LMs will be assessed again with a quiz in similar testing conditions and with the same test bank. Both quizzes will be graded for completion and will not impact their grade; we plan to hide their scores too after they finish the exam. There is also an open-ended reflection question about each module for each student to complete at this end of semester quiz. At the end of the semester, after grades have been posted, we will administer a quiz inquiring about the

effectiveness of these modules and how confident LMs are on each skill. LM will rank their confidence on a five-point Likert scale on the key points of each module's video; For example, regarding conflict management, we asked LM how confident they were in their ability to handle problems and conflicts in a team setting.

### **Results and Discussion**

During the Fall 2023 semester pilot study, LMs were not required to watch the module videos; thus, there was minimal incentive for the LMs to learn from these videos. The watch rate of the videos ranged from 28% to 44%, indicating that the module videos did not have a substantial effect on the LMs' understanding. Furthermore, the student feedback in the end-of-the-semester survey recommended the inclusion of more active learning strategies such as role playing in-person. LMs suggested that we make the learning module videos mandatory and activities more engaging.

For the upcoming semester, we plan to introduce each video module throughout the semester with in-person exercises to supplement the modules. Each module will be introduced at an appropriate time to best prepare the LMs to help students with what to come next in the course. For instance, the group development module will be introduced at the beginning of the semester to teach LMs how to better facilitate group interactions and development. The public speaking module will be introduced towards the end of the semester to aid with the first-year students' final presentations, which occur in the last week of classes.

The LM course is taught in a flipped classroom, asynchronous format, which some students found challenging. Improving interaction and clarity between instructors and LMs will be crucial for enhancing mentorship and leadership training in future iterations of the course.

In the upcoming semester, we will obtain baseline and post-semester quiz results to assess LM knowledge on the leadership modules. To gauge the effectiveness of the modules in shaping the LMs to become better leaders, we will also collect survey results pre- and post-semester on their confidence in leadership and knowledge in the module topics. Thereafter, we will analyze the results to evaluate the efficacy of the modules in developing better mentors and engineering leaders.

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