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Work in Progress: Factors Influencing Career Choice and Success in Undergraduate BME Students

Dr. Tyler George Harvey, Clemson University

Tyler G. Harvey is a Lecturer in the Department of Bioengineering at Clemson University, where he also received his B.S., M.S. and Ph.D. His teaching focus is at the undergraduate level and includes a variety of required and elective courses including capstone design, bioinstrumentation, and biomechanics. His research interests are in developing outreach programs which increase interest in engineering, especially from underrepresented students and alternative methods of student assessment.

Work In Progress: Factors Influencing Career Choice and Success in Undergraduate Biomedical Engineering Students

Introduction

The field of biomedical engineering (BME) has witnessed significant growth in recent years, driven by advances in technology and a growing emphasis on healthcare innovation. This growth has led to a large range of post-graduation career paths for BME undergraduates including medical and professional school, graduate school, and direct employment as engineers in the medtech, biotech, and healthcare industries [1]. Much of the literature on career choice and motivations of these students focuses on their plans at a static time point [2]. Often this time point corresponds to their entry into college or into a BME major [3-5] or shortly before or upon completion of their undergraduate degree [6-7]. The purpose of this work is to "fill in the gaps" and understand how and why the career plans of these students change throughout the course of their undergraduate degree in response to their interactions with the curriculum, participation in extracurricular experiences in research, industry, and clinical settings, and other external factors.

Data Collection and Analysis

This study has been determined to be exempt by the Clemson University Institutional Review Board and granted a FERPA exception by the Clemson University Registrar's office under IRB #2023-0810. Under this protocol, copies of all completed course assignments in which students reflected on career plans and motivation were collected directly from course instructors for two required courses in the Biomedical Engineering (BME) curriculum:

Sophomore Seminar: This is a required course which is usually taken by students in their first or second semester of joining the BME major. The course meets once per week and covers a variety of topics including career paths, curriculum planning, biomedical ethics, and professional development opportunities. Currently, data has been collected from three separate instructors since the Spring 2019 semester. The specific assignments collected vary slightly by semester and instructor, but in general consist of at least one free response question asking about students future career goal, a free response questions asking about concrete steps they plan to take during their undergraduate career to achieve those goals, and a copy of their professional résumé at the time they were enrolled in the course.

Capstone Design: This is the first of a two-semester sequence and is usually taken two semesters prior to graduation. The course meets twice per week and covers basic principles of the design of medical devices while students work (in teams of 4-5) with clinician sponsors to identify clinical needs and propose a novel design solution. Currently, data has been collected from two co-instructors since the Fall 2017 semester. The specific assignment collected consists of a short answer question in which students succinctly describe their post-graduation plans, a free response question which asks students to reflect on their personal strategic focus as a member of the BME community, and a copy of their professional résumé at the time they were enrolled in the course.

To date, we have collected over 1000 individual student assignments between both courses and are currently in the process of pairing them so the same students can be tracked across the two time points. In addition to the students' assignments, we are also collecting information about the first position students attained post-graduation, if available, from public sources such as

LinkedIn or the alumni directory. Once data from all three time points is collected for a student, all the assignments are anonymized with all specifically identifiable information removed. Information about their current position and company is coded into broad categories that are not identifiable (e.g. "Engineering Role at Medical Device Company") to any individual.

In parallel, as data is deidentified we have begun the process of transcribing and coding individual responses to course assignments into a discrete set of career plans to allow for quantitative data analysis while retaining the complete responses for qualitative analysis in the future.

Initial Results and Observations

One of the initial motivations for conducting this study is to assess our undergraduate program's effectiveness at preparing our students to achieve their post-graduation career goals. From the data collected and deidentified thus far, we compare the post-graduation plans of students reported at the start of capstone design (typically two semesters prior to graduation) to the first post-graduation position the students public report via LinkedIn or the alumni directory. In each case, the data is coded into broad categories of career paths to allow a direct comparison between the points. Aggregate data from students in the classes of 2020-2023 are included in Figure 2. A McNemar-Bowker test for multiple correlated proportions was conducted for each cohort, with only the class of 2022 having a significantly different distribution of responses between the start and end of senior year. We hypothesize that this is due to the COVID-19 pandemic and its effect on higher education and the broader economy in the 2021-2022 school year. Despite the lack of significance in other cohorts, we have made some general observations that we are interested in exploring with further analysis :

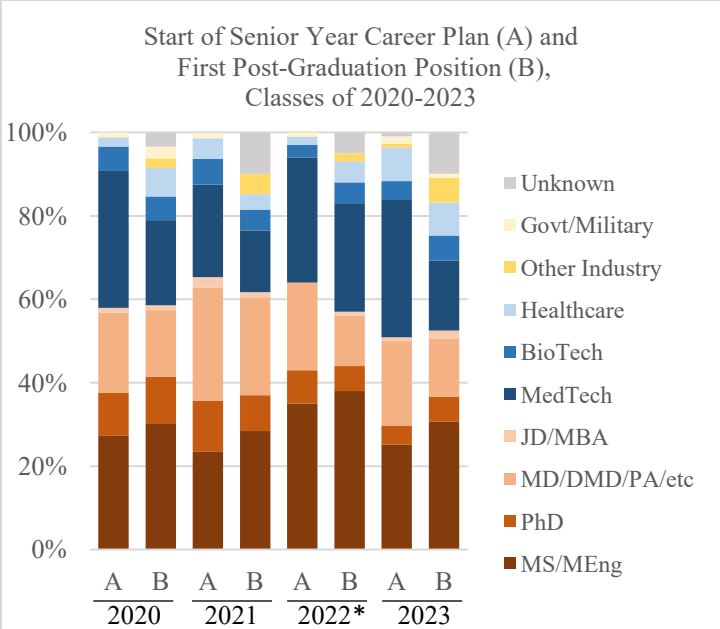

*Figure 1: Assignment responses and post-graduation positions were coded into broad categories of career paths to allow direct comparison between the data points for the classes of 2020 (n=88), 2021 (n=81), 2022(n=100) and 2023 (n=111). *Statistically significant ($p<0.05$)*

1) On average, 10% more students pursue a masters degree (either MS or MEng) in BME or a closely related discipline directly after graduation than plan to at the start of senior year. We are very interested in the causes of this shift (both positive and negative.) Since these students plans at the start of senior year are evenly split between PhDs/professional degrees (5%) and industry (5%), some potential hypotheses to explain this shift include:

- Students are unable to secure any job and stay to pursue a one-year masters degree. This may the corresponding lower percentage of students securing MedTech industry jobs compared to those planning to enter this field at the start of senior year.
- Students planning to enter a professional health field are unable to gain admittance to

medical (or related) school and stay to pursue a one-year masters degree while they reapply, or intentionally defer admittance to purse a masters during their gap year. This was observed particularly in the 2022 cohort, where 25% of students planning to attend professional school enrolled in a masters program instead.
- Exposure to advanced technical elective courses and undergraduate research opportunities during the senior year cause students to reconsider further study or research in these areas during a masters program.

2) The majority of students plan to pursue some form advanced degree before beginning their professional career. While perhaps not uncommon among BME undergraduates, it is among those in other disciplines. Since this data only reflects student plans near the end of their undergraduate career, we are interested in when this decision to pursue an advanced degree is made and how students' perceptions of BME as a major and career field influence this decision making. Because of the richness of the data collected at the sophomore year time point, we hope to be able to address these questions through both quantitative and qualitative methods as more data is available within the database.

3) The percentage of students planning to pursue (and actually pursuing) a PhD is steadily decreasing over time. We are interested in this trend and whether it is transient (and perhaps related to the COVID-19 pandemic) or a growing trend within our students and the discipline more broadly. Related to this, in our initial analysis of data at the sophomore time point, we have seen that the majority of students who successfully matriculate to a PhD program are those that have planned to do so since at least the sophomore year. We hope more detailed qualitative analysis of both groups of students (those who decide on PhD early and those who decide later in their undergraduate careers) will yield insights into student decision-making about pursing doctoral degree programs and how well our undergraduate programs support them.

At the conclusion of the data collection and de-identification process, we expect to have a rich set of data which captures the motivations, career plans, and participation in professional development for nearly all of the students who have completed our BME program during the past 5 years. This will allow a unique opportunity to deeply understand the needs of our most important stakeholders and make informed decisions about the future of our undergraduate curriculum and extracurricular programs.

Limitations

Because each course instructor developed their own assignments, there is a lot of variability in the wording between assignments, especially at the sophomore level. This may limit the ability to make one-to-one comparisons between cohorts. Additionally, since we are dependent only on a retroactive analysis of already collected assignments that are subsequently deidentified before analysis, there is no opportunity to follow up with individual students to explore additional questions and observations that may arise during analysis.

Acknowledgments

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