Inviting Industry Guest Speakers to Improve Undergraduate Student Understanding of Career Options

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***Abstract*— This research full paper describes the impact that diverse industry and career speakers can have on undergraduate student's career perspectives in bioengineering. The career prospects for bioengineering (BE) students can be confusing, with a diverse range of opportunities and job descriptions that do not clearly illustrate the daily experiences of the engineers. Often, graduating students are unaware of what a professional engineer does in the field and how what they have learned and experienced in school will be applied to their work. To provide students with a clearer understanding of the possible roles and responsibilities they would have in careers, we invited a variety of engineering professionals (e.g., from Abbott, Stellantis, Tech Startups, Teijin, Exon, Graduate School) as guest speakers to an upper-level undergraduate biomaterials course for mechanical engineering (ME), bioengineering, and dual majors. This course element was designed to allow students to hear about various companies, positions, and daily activities from multiple sources and ask questions that were pertinent to them and their career interests. To assess what students perceived as valuable from their interactions with the guest speakers, students were asked to submit questionnaires at the beginning of the semester, after each career presentation, and in end of semester evaluations. In these surveys, students responded to open-ended questions about the usefulness of the career talks, what they took away from the presentations, as well as a self-report of the impact of the talks on their career outlook. Survey responses were inductively coded to explore how students' interactions with guest speakers impacted 1) how they will apply for jobs, 2) what out-of-class experiences might be valuable for students' future career search endeavors, and 3) what roles and responsibilities students might value in a future career. Results of this paper will detail findings within those three themes and provide suggestions for how guest speakers can improve students' understanding and subsequent pursuit of career opportunities in BE and ME.**

Keywords—bioengineering careers, mechanical engineering, guest speakers

I. Introduction and Motivation

Biomedical (BME) and bioengineering (BE) fields are frequently recognized as interdisciplinary, and is well-known for the breadth of job opportunities available to BME/BE students upon graduation [1], [2]. At first glance, this breadth appears to be a strong benefit for students in the field, but studies have shown that it also comes at a cost. Studies have demonstrated lower industry interest in hiring BME students and lower starting salaries at their institution [3], [4] indicating some level of disconnect between the perceived benefit of breadth of career possibilities and actual placement in industry.

Researchers have explored this disconnect from multiple angles. Studies have developed career services tools that can be used to examine the impact of such tools on BME career searches and attainment [5], examined what experiences students believe can help prepare them for careers [6], [7], and interrogated what employers are actually seeking in prospective employees [8], [9]. These studies have provided insights into what employers are looking for in students, lending information on the key skills needed and tasks students are likely to perform in entry level jobs [8], [9]. They have also developed tools to help support students in communicating their skills to prospective employers through the use of BME specific career pathway resume rubrics [5].

Current research also provides insights into how students navigate BME degree pathways in relation to their desired careers, articulating the impacts of both in-class and out-of-class experiences on career pathways in BME/BE [6], [7]. For example, Woodcock et al. [6] found that BME students participate in design oriented and research oriented experiences largely for their perceived utility for securing jobs upon graduation, while other motivating elements (e.g., general interest and identity attainment) played varied roles for students in the two types of experiences. Desing et al. [7] found five themes related to supports and barriers of career attainment in BME including implications of 1) interpersonal relationships, 2) institutional infrastructure, 3) academics, 4) social identity, and 5) out-of-class experiences.

Still other researchers have explored career aspirations [10] and career pathways [11] of BME/BE students in relation to other engineering majors finding that in first-year engineering students, being a BME major was associated with a decreased certainty of an engineering/industry career. In that study [10], interest in an industry career was also associated with higher measures of engineering identity. In a later study by the same research group [11], the career pathways of BME, environmental engineering, and interdisciplinary engineering majors was examined, uncovering that though engineers in these fields frequently move into and out of engineering positions

during their early careers, many also articulate connections to engineering in positions that would typically not be considered engineering.

In relation to exploring how BME/BE professionals come to understand what a BME/BE career is, relatively less work has explored what students expect BME professionals will do or how students come to understand what BME/BE professionals actually do [12], [13]. For example, Ramo et al. [12] explored the changes in how BME students defined BME before completing a core BME required course and after completing at least one required BME course. Their work found a shift from impact-oriented definitions (e.g., to benefit humanity) from students who had not yet taken a BME course to application-oriented definitions (e.g., to apply technical knowledge to solve a problem) for students who had taken at least one BME core course. Potvin and colleagues [13] looked at gendered engineering career interests, comparing career interests of male and female students in both BME and electrical/computer engineering, finding a similar theme of 'helping others' as relevant to female students' higher representation in BME. Both [12] and [13] have contributed to our understanding of what students perceive as relevant elements of BME careers, namely the ability to help others and apply technical knowledge, but the field still needs to understand how students come to recognize those elements as key factors in BME/BE careers.

In summary, research in this area has explored what employers are looking for in BME/BE employees, what pathways students expect out of a BME career and the activities they participate in to prepare themselves for their desired careers, and how students come to understand what BME/BE as a field is. Evidence of how students come to understand what professional practice looks like in BME careers though, is not as clearly understood. To build upon the work in this area we wanted to investigate how exposure to a variety of careers in the BME and ME fields could impact students' perception of job prospects and ideally get them thinking about their futures more effectively.

Our work looks at one specific example of a course-based intervention that seeks to investigate how guest speakers from a variety of BME/BE professional positions informs students understanding of how they will apply for jobs, what experiences they should seek out to support their professional preparation, and what BME/BE professional roles and responsibilities they are interested in. To expose students to a variety of job opportunities, various speakers in bioengineering and mechanical engineering industries were arranged to speak about their work and how they attained their current positions in a required bioengineering course. Students were able to ask questions and filled out a feedback survey after each presentation describing their perceived impact, relevance, and take aways that they could apply to their own situations. These survey responses were then analyzed for themes and assessed for impact on student outlooks on job awareness and interests. Based on the inductive nature of our study design which will be discussed further in the next section, we also found that students took away information about how to navigate careers once they have attained positions.

II. Study Design

This study leverages survey reflection responses to explore what students learned about BME/BE careers in a one-semester, required bioengineering course on biomaterials and tissue engineering housed in a mechanical engineering department when a series of external guest speakers are invited to give lectures about their careers. Based on emerging literature that seeks to understand BME students' perceptions of what BME/BE careers look like and the landscape of BME/BE career opportunities, our study sought to explore the following research question:

How does attending a series of guest lectures impact how students are thinking about BME/BE career opportunities while in their BME/BE degree programs?

A. Study Context

The participants of this study were enrolled in a tissue engineering and biomaterials course at a public, R2 institution in the Midwest United States. This course is a required course for bioengineering students that typically enrolls third- and fourth-year students. The course covers topics on biomaterials (e.g., structures, properties, therapeutic applications, and technological challenges) and seeks to develop students' ability to apply their new biomaterials knowledge to solve problems in the field. Because the course is offered out of the Mechanical Engineering (ME) Department where the institution's BE major is housed, students in the course are either ME or BE students who may have varying degrees of interest in BME/BE oriented career pathways. In Fall 2024 when the course was offered and this study was performed, 14 students were enrolled. The first author of this paper was the sole instructor of the course where this study was performed.

B. Job Talks

Participants in the study attended eight presentations from professionals with BME/BE, ME, or hiring professional experience to help ensure that students enrolled would have opportunities to hear from professionals in career areas of their interest. The guest lectures were framed for students as an opportunity to increase their exposure to opportunities in engineering. Speakers with backgrounds in industry (n=5 speakers), academic (n=2 speakers), and human resources (HR) contexts (n=1 speaker) were represented. Companies included: Entelexo: a biotherapeutics company, Teijin: a pharmaceutical company, Abbott: a medical devices company, Stellantis: an automotive company, and ExxonMobil: an oil and gas company.

Each speaker was tasked with discussing their job search process (if they had applied recently) and a day in the life of what they do as their profession. Based on their background, speakers were also individually asked to discuss topics like how they applied materials-science-related knowledge in their job, what the interview process looks like from the hiring side of things, or bioengineering opportunities within their company in their talks. Presentations lasted approximately 30-45 minutes, and participants had 15-30 minutes dedicated for them to ask speakers questions.

C. Data Collection

The data collection and analysis approaches used on this study were reviewed and determined exempt by the institutional review board where the study took place. Survey data were collected shortly after each speaker visited the class. Responses were not anonymous to the instructor so that students could receive participation credit for completing the survey about each speaker. Participants were asked three short questions were about the speaker's presentation: 1) What did you learn from this guest speaker? 2) Did you find this presentation helpful? What aspects of this talk do you think will help you in your future career and why? and 3) Any additional feedback you would like to provide? Participant responses ranged in length from one sentence to short paragraphs (3-5 sentences) per question. In total, 122 total responses were collected and analyzed.

D. Data Analysis

We performed an inductive analysis [14] of responses guided by our interests in understanding the impact of the intervention on participants understanding of the job application process and what they might be interested in as a future career. As such, author one performed an initial read of the data, capturing codes that were placed into three categories: applying to jobs, experiences, job tasks. Author one performed data analysis synchronously with code definition and application reliability support from author two as needed.

After preliminary coding was complete, we met to discuss code definitions and examples in the data. Codes were combined and split as needed to capture the nuances in participant responses and address our research questions. Table 1 details the codes we developed and provides examples of participant responses.

TABLE I. DATA ANALYSIS CODES

Category	Code	Example
Applying to Jobs	Company Fit	I think it was also important to know that "I am also interviewing the company" to make sure that it would be a job I would enjoy working at, something that I never really thought in depth about.
	Improving App Materials	I think an aspect […] would be how to fill out my resume. […] hearing other peoples interviewing experience so I know what I might need to expect for the future. […] learning how to write my resume will help me secure a job.
	Negotiating	I also was able to learn a good amount of […] negotiating tips (like salary or benefits).
	Application Time Commitment	It had also put in perspective just how time consuming and involved finding the right job can take.
	Value of Networking	I learned that you need to network, network, network!
	Application Process	She stressed the importance of getting to the fall career fairs to talk to the companies of interest in order to have the most positions open to you as possible.
Job Tasks	Day in the Life, Expected Responsibilities	Gave insight into how a biomedical position would look as a career which is especially useful for the BENG program as I feel we have little interaction with the BENG job opportunities unless you go to speak with some during a job fair.
	Industry/Academic Operations	I learned a lot more about the structure and different "departments" of Exxon Mobile which made these large corporations seemed a lot less "daunting" to apply for. I enjoyed learning that gas companies aren't entirely "only-for-profit" companies.
	Insight to Job Interests	I thought the presentation was helpful and informative. I think patent law could be very interesting, and it is something I will consider later in my career.
	Getting Started	The breakdown of what roles and the timeline was also useful to give more a picture of what the first 10 years or so may look like.
	Career Paths	I learned the importance of having specific career goals for yourself is, especially visualizing the path and understanding the path necessary to get to that/those position(s).
	Mentorship	I also appreciated the insight on how important it is to have a manager that you can work well with and be comfortable with asking them questions.
Experience	Get More	I learned that internships are super important to get experience. It's important to do some extracurricular activities during college to put on a resume.
Personalized Experiences of Career Navigation	Awareness	I also learned about some of the programs that automotive companies have for younger engineers to move through the company while getting their master's paid for, like the rotational program she completed.
	Self-Advocate	I really like how she spoke up for herself and found herself at a position she had enjoyed much more, proving to us that sticking up for our wants is something you must do.
	Normalize Uncertainty	It was nice to listen to someone talk about being unsure of what they want to do with their career.

We then explored the data to look for patterns of responses based on the speakers' backgrounds, including the career sector (e.g., industry or academia) and size (e.g., start-up), current role in the profession (e.g., professor, hiring manager, etc.), and career trajectory of the speaker (e.g., has held multiple

positions, is new to the field, number of degrees held). Results of our analysis are provided next.

III. Results and Discussion

A. Most Common Takeaways from Speakers

Students had two takeaways from the speakers that appeared across the kinds of speakers that were hosted: insights into the application process and advice on getting more experience. Depending on the kind of speaker (i.e., HR, industry, or academia), students talked about varying insights on these two takeaways.

For example, insights from HR on the application process largely focused on what recruiters are looking for, the job hiring process in general terms, and the perspective of hiring from the company's point of view. Students also mentioned learning about the hiring process from industry speakers but talked more about the application process from the prospective of an employee and about the extent of applications that are needed to attain a single position. From academic speakers, students talked about learning about the process of applying to graduate school as well as how the interview and evaluations are performed in order to get into a specific program.

While all centered on the application process, each type of speaker shared a slightly different perspective on what an application process will look like. When considering what sorts of speakers to invite to a course if you are seeking to support your students' understanding of a career search, these differing perspectives highlight that expectations of the application process may differ based on their future goals which may mean it is necessary to invite a diverse group of speakers to serve all of your students interests, or invite speakers based on what you know about your students' career interests.

Similarly, the advice on getting more experience students received varied by speaker type. When hearing from the HR speaker, students took away the importance of having outside experiences generally as a way to improve their applications. On the other hand, the advice about experience that students took away from industry and academic speakers focused on specific types of experiences (e.g., internships, co-ops, and other extracurriculars related to specific job sectors) that would benefit them in a career search. These findings further highlight the value of bringing in multiple kinds of stakeholders to help students understand the basics of what entering a career looks like and what specific experiences can be beneficial to their next steps based on where they would like to end up.

B. Unique Takeaways from Speakers

Each speaker contributed their unique perspective on the hiring and experiences within their position. The student responses showed 3 unique takeaways present in only one of the four speaker types (i.e., HR, BME industry, Other Industry, Academia): negotiating, normalizing uncertainty, and mentorship.

The negotiating code only appeared in the human resources presentation. Students stated that hearing about interviewing skills such as negotiating was helpful and informative, and some claimed was the most helpful part of the discussion. Students who mentioned negotiating talked about not having the confidence or background knowledge to anticipate what the negotiation process would look like, and that exposure from the HR speaker was helpful in knowing what to expect when they go to that stage of a job search.

Normalizing uncertainty was only noted in the academia category of talks. This code represented instances of when students talked about realizing that uncertainty in their future was not abnormal, and that seeing that uncertainty reflected in someone else's journey enhanced their comfort with the idea that uncertainty is a normal part of navigating a career. The students reflected that it was, "nice to listen to someone talk about being unsure of what they want to do with their career". BME/BE is a broad field and navigating the vast opportunities available as a BME/BE can be daunting. It was promising to find that students found the talks helpful in normalizing the uncertainty associated with finding a career that is fulfilling.

The final unique code, mentorship, was found in the industry-BME category of talks. Students pointed out that they learned about the importance of the mentorship you receive from managers that you can work well with, feel comfortable around, and are able to approach with questions. We anticipate this advice will be helpful for students who are navigating a choice between two otherwise similar career opportunities, both in academia where mentors are PhD advisors and in industry, where mentors are supervisors.

These takeaways were unique to specific kinds of speakers, and many were mentioned by only a few students in the class. This finding shows the importance in not only the diversity of speakers to present their unique stories, but also that the speakers stories can results in a personalization of topics that students retain and apply to their own experiences and future path.

C. Unique Takeaways from Industry Speakers

When comparing the industry specific speakers to academia and HR, two unique codes were found. In the BME or other category of industry talks, getting started, as well as, career path, were explicitly mentioned in the students' discussions of the industry talk takeaways. The, getting started, code referred to observed takeaways students mentioned from the perspective of just starting their careers, and how this advice may be of benefit to them. Students mentioned it was helpful to hear from individuals that have just started their careers, so they are the most relatable and closest to the position they are currently in, seeking jobs in the near future. Students also mentioned gaining perspectives of what a general first few years of a career might look like in terms of roles and responsibilities, which they described as helpful information. We anticipate these insights will be useful as students step into their first jobs and have some idea about what they might be asked to do or what opportunities to seek out in their first few professional years.

The career path code was mentioned in several of the industry speaker feedback forms, across both industry-other and industry-BME. This referred to students thinking about acquiring a job as a step in their career, not just as the next necessity after graduation. They mentioned the speakers pushing them to think about what they see for themselves in the future and how they want to pursue that vision most effectively. They

often mentioned this code with reference to deciding on what they want their future to look like and ruling out what future paths they did not want to pursue. This type of forward thinking appeared to push students into thinking of their future in longer terms rather than individual unrelated steps. We found this code to be one of the most promising outcomes of the guest speaker talks, as it is often difficult to get students to take a step back and think about their long-term career goals and the possible steps to get there.

D. *Uncovering the Personalized Experiences of Career Navigation*

A major takeaway from the student responses to speakers was the impact of personalized experiences and how they were individually applicable to each student. Many of the students mentioned these talks as both informative from the perspective of what they did or did not want to consider in their future paths. We captured these personalized impacts in codes that were grouped as Personalized Experiences of Career Navigation. Here, awareness, self-advocate, and normalizing uncertainty were quantified. We discuss the awareness and self-advocate codes next since normalizing uncertainty was already discussed in the *Unique Takeaways from Speakers* section.

The awareness code, referred to the many times students mentioned that a specific talk or topic discussed made them aware of an opportunity or circumstance that they did not know about before. A couple of examples include: graduate school and funding opportunities, the range of job opportunities available in BE/BME, commitment and specific job requirements, how application processes differ, and how class material can be applied in their future careers. This speaks to the necessity of exposing students to and making them aware of as many opportunities as possible for their future because without this knowledge of opportunities they can not pursue what they do not know exists.

The code, self-advocate, appeared in response to several speakers, where students reiterated the realization that they need to speak up and be confident in the presentation of themselves to employers. They also mentioned admiring the stories from speakers that had to advocate for themselves in order to get where they wanted in their career. It was important for students to hear that actively pursuing what they want in their career and future often comes with self-promotion and the need to speak up for themselves. While we acknowledge that having speakers discuss this reality alone will not be sufficient to support students in their ability to self-advocate, we hope that bringing this element of career navigation to their attention will encourage them to seek out opportunities to improve their self-advocation skills.

IV. Conclusion

Overall, the goal of this study was to evaluate the impact that speakers could have on a student's perspective of their future career and their understanding of how to pursue that goal. The diversity in responses highlighted the importance of a diverse group of speakers and demonstrated the unique takeaways that each student found applicable to their own situation and personalized pursuit. The inherent diversity in each presenter's talk and experience enabled the broadening of the students' awareness and knowledge about what opportunities are available to them beyond college as well as how to pursue the path that suits them best. This effort focuses less on skills development and more on career opportunity exposure. Based on participants' responses, these perspectives are also valuable elements of an engineering education in that it helps them to understand what they can and should expect out of the transition between an undergraduate degree and an industry career or graduate program. In all, this course addition demonstrated a relatively simple way to improve students' understanding of career searches and navigation.

While not explicitly explored from the perspective of the external speakers, we also think this effort can provide opportunities to foster and maintain connections between higher education institutions and industry representatives, leading to curriculum that is more consistently informed by industry perspectives. Future efforts that bring in external industry speakers as part of the course may wish to explore the impact of those relationships on their course offerings, including influences on the topics covered, technology taught, or contexts used for project examples.

In future iterations of this initiative, we would like to diversify the range of education and age of the speakers. Students had mentioned it was more helpful hearing from individuals closer to their age and experience level that had graduated recently and would reflect the current job market conditions they could expect. Additionally, we would like to include more speakers and open the discussions to a wider audience in the department of engineering to allow undecided students to learn about BE/BME opportunities and begin thinking about their careers as early as possible. Future research exploring the impact of similar talks might seek to capture information about students' career interests and aspirations as a way to explore what they learn from speakers of different backgrounds based on those career interests.

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