Promoting Career Reflection among Freshman BME Students

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Introduction

The biomedical engineering (BME) program at Arizona State University (ASU) includes a 14-week 'success' course in the freshman fall semester. The primary objective of this course, ASU101, is to introduce students to BME faculty and ongoing research in the department, and a secondary objective is to introduce students to a few topics important to their university success (e.g. academic advising, academic integrity, and career search resources). In our co-taught version of this course, we also emphasize helping students to understand realistic career paths for graduates with B.S.E., M.S. or PhD degrees in BME, and to set and work towards their personal career goals. Our additional objectives are motivated by the hypothesis that many students entering our BME program do not have a clear sense of the jobs or career trajectories available to them upon graduation, and that many do not hold realistic expectations of what they can expect to do in an entry-level job.[1]

In Fall 2015, we piloted a set of reflection activities with our co-taught section of this BME success course (18 students, of which 15 consented to participate in the research study). Through these activities, students were encouraged to reflect on their choice of BME as a major, to articulate their career and personal goals, and to identify actions they could take while in college to help achieve their personal and professional aspirations. By integrating regular reflection, we aimed to empower students to take ownership of their university educations, to develop an understanding of realistic job opportunities available to BME graduates, and to be pro-active in defining their career and personal aspirations. By comparing student responses to a set of open-ended survey questions in the first week and final week of class, we sought to evaluate the impact of these reflection activities on students' understanding of BME career paths and their ability to articulate their choice of major.

This paper builds directly on our 2015 study, which was presented as a Work-in-Progress at the 2016 ASEE annual conference.[2] Based on our findings from Fall 2015, for 2016 we developed a more detailed online survey geared towards the entire incoming class of freshmen (not just our class section). This survey is described in detail in the *Methods* section. In Fall 2016, this survey was offered at both the start and end of semester to all students just entering the BME program, with the aim of tracking changes in student perspectives over their first semester. The pre-course survey was completed by 117 students, including the 19 students enrolled in our section; 41 students completed the follow-up, post-course survey, including 10 students in our co-taught section.

In this study, we seek to answer two related hypotheses. First, we hypothesize that biomedical engineering freshmen have vague and/or unrealistic expectations of typical jobs available to a B.S.E. biomedical engineer upon graduation. Second, we hypothesize that our freshman success course can help students to set more realistic and specific expectations for their career prospects. One metric for this is tracing the ability of our students to articulate specific job functions available to graduates with only a Bachelor's degree in BME. Another metric for this is matching student intentions for their own post-graduation careers with a realistic expectation of whether they will require postgraduate study. Other, related indications include students' ability

to set goals that will further their specific career aspirations. These might include switching out of the BME major altogether, if students realize it will not get them to where they want to be.

Methods

Course structure

Our class section of 18 (Fall 2015) and 19 (Fall 2016) students met for 50 min per week over 14 weeks. All students completed weekly reflections as their homework assignments. The weekly reflections comprised a variety of exercises, including:

- **Reflections about students' personal goals.** In Fall 2015, these reflections were based on a seminar course at Harvard called 'Reflecting on Your Life'.[3] We incorporated four of the reflection activities described for the Harvard course as homework exercises early in the semester ("Time Allocation", "Developing 'deep' vs. 'broad' expertise", "Core Values", and "Life Aspirations"). Students completed each exercise based on instructions we provided, and wrote a short response to each reflection activity. In Fall 2016, we kept the time allocation activity, and replaced the other reflections with short assignments inspired by examples from *Studying Engineering* by Raymond Landis,[4] focusing on topics including goal-setting and reflecting on different engineering job functions.

- **Career preparation exercises**. In Fall 2015 and Fall 2016, weekly student assignments included preparing a résumé, attending and reporting on a university-hosted career exploration event, and reflecting on their visit to the engineering career services center. In Fall 2015, students also took an online assessment (Indigo) designed to measure workplace competencies (similar to a personality test and DISC assessment combined).

- **Academic success planning.** In Fall 2015 and 2016, students were asked to make a personalized major map, and to annotate an ABET student outcomes rubric with information on what parts of his/her college experience would help the student master different outcomes. In Fall 2016, we also added an activity relating to learning styles, and a written reflection on learning from failure.

- **Written reflections on guest presentations.** Students were asked to write short reflections on talks given by faculty presenters and alumni from our BME program. Faculty talks typically focused on their career trajectories and research expertise, while alumni talks focused on sharing experiences of the BME program and discussing the day-to-day life of different BME career options. In 2015, one talk was given by an alumna in medical school who focused on next steps for getting into medical school (an option that typically about 1/3 of our BME students are considering when they enter the program), and another alumna described her career path in intellectual property after graduating from the BME program. In 2016, we made a specific effort to have presentations from an alumna in a regulatory affairs position, and another in a technical sales / clinical engineering position. These talks focused on the day-to-day job functions of these positions, the requirements for being hired into one of these positions, and what students should do during their time in college to prepare for these positions if they desired them. We also brought in a postdoctoral researcher who had recently

graduated from our PhD program, to speak with students about the process of applying for and completing a PhD.

- **Final design project**. In Fall 2016, a semester-long design project was also introduced, again drawing inspiration from Landis' *Studying Engineering* textbook. Students were asked to draw on their homework assignments and activities to prepare an end-of-semester design report focused on developing their own personal process for becoming a 'world-class' (engineering) student. The 4 core sections of the report focused on (i) goal setting, (ii) personal development, (iii) academic development, and (iv) career development.

Online survey

In fall 2105, 15/18 students signed consent forms to allow their homework assignments to be analyzed as part of our IRB-approved study. In fall 2016, all 19 of our students and 98 students in other professors' sections agreed to be part of our IRB-approved study, which comprised a pre-course and a post-course online survey.

Fall 2016 surveys administered via SurveyMonkey.com during the first and final week of classes focused on student motivations for choosing BME, their understandings of the career options available for BME graduates, and several specific questions related to techniques for achieving academic success. In the Fall 2015 study, all questions were open-ended; we analyzed written responses to identify frequently mentioned keywords and themes, as well as unique responses across the student cohort. The Fall 2016 surveys contained some open-ended questions as well as a number of forced-choice/multiple choice questions; the latter were implemented with the aim of being able to better quantify responses for specific topics, for example, we specifically asked students to indicate whether they planned to do research upon graduation, and we also asked whether they intended to pursue a PhD after graduation.

In analyzing the Fall 2016 survey results, we analyzed responses to the following open-ended questions: "Describe what you think a biomedical engineer with a B.S.E does in their job. (For example, someone 2-3 years after graduating with a B.S.E. in BME)" and "List the kinds of jobs that a graduate with a B.S.E. in Biomedical Engineering could hold within about 5 years after graduating." Based on key themes from the Fall 2015 dataset, these responses were tabulated according to the presence or absence of the following words: (a) "research", (b) "design, (c) "solve" or "solving" (as in solving medical problems), (d) "help" (as in helping the world or helping patients), (e) "don't know", "do not know", or "no idea", (f) "quality" (as in quality assurance) or "product testing", (g) "regulatory" or "FDA", or (h) "sales". Individual students' pre- and post-course survey were compared to track similarities or changes in their responses.

Forced-choice survey questions included asking students whether they planned to conduct research in their career (answers: yes, no, not sure) and whether they planned to pursue a PhD after graduation (answers: yes, no, not sure). These responses were paired for each respondent to create a 3x3 table tabulating all possible response combinations (Table 1). We also paired responses to questions about the level of importance students attributed to having a detailed plan for graduation, and their self-described proficiency in developing their own plan for graduation.

The difference between the Likert-scale responses to these two questions are calculated and discussed.

Finally, some basic quantitative data was extracted directly from the survey responses. These include the raw numbers of students indicating a likelihood of continuing their education towards MS or PhD degrees, and confidence in their choice of BME as a major. Our IRB-approved study also gives us permission to track whether students change major, so we have included details for our co-taught section regarding students who chose to change major during or after completion of their Fall semester studies.

Findings

1) Motivations for choosing BME

In Fall 2015, we observed that students' motivations for choosing BME remained largely unchanged from beginning to end of the semester. They expressed a variety of personal motivations for entering the BME program, but common themes emerged across the surveys. In Fall 2015, every student (15/15) aspired to use biomedical engineering to help others and/or the world in some way. Common responses also mentioned being good at some combination of science / biology / physics / math (9/15), and interested in medicine / medical developments / engineering (8/15), but not wanting to pursue medicine to or work in a medical setting (5/15). Some students noted a wish to enter BME because of personal medical experiences or those of family members or friends (3/15). Several students cited good job prospects for biomedical engineering graduates (6/15), but the pre-course survey responses did not indicate familiarity with specific jobs available to BME graduates. One student indicated that BME was a good choice for them because the BME requirements included most of the courses they needed to qualify for medical school admission; she also talked about the importance of being a woman choosing a STEM career.
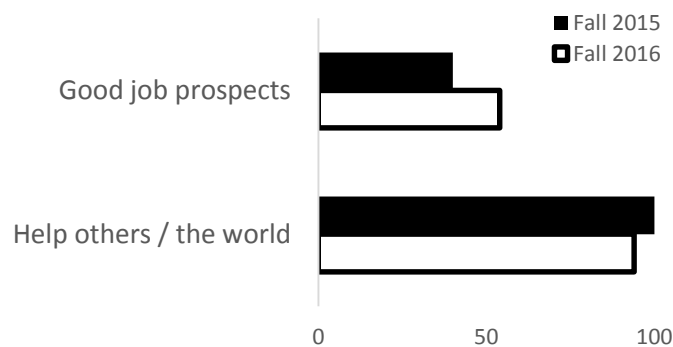

Figure 1. Percent of students in pre-course survey indicating that their reasons for choosing BME as a major were driven by: good job prospects (top) or a desire to "help others or the world" (bottom) in Fall 2015 (black) and Fall 2016 (white).

Identifying these themes in the Fall 2015 data was performed by coding and grouping student responses to identify the minimum number of different themes needed to describe all the core ideas presented within the dataset. Based on these responses, we turned a number of these themes into specific questions for the Fall 2016 survey, using Likert-scale responses to help synthesize across a larger cohort of students (117). In the pre-course responses to the statement

"Biomedical engineers contribute to making the world a better place," 110/117 students responded 'agree' or 'strongly agree'. While this statement does not indicate causality for influencing choice of major, it does suggest that this is a strong positive feeling students have about biomedical engineering. Students' response to "My primary motivation for choosing engineering is the solid job prospects of engineering graduates" include 35/117 'neither agree nor disagree', 50/117 'agree', and 13/117 'strongly agree'. Thus, job prospects seem to be an important factor for a majority of incoming BME students. Given this, having a clear understanding of what those job prospects are seems important.

At the end of the semester in both Fall 2015 and Fall 2016, most students' broad motivations for being interested in BME had not changed appreciably. However, 2/15 students in our Fall 2015 section and 6/19 in our Fall 2016 section had decided to switch out of the BME major. These students switched to majors including business, journalism, psychology, kinesiology, engineering management, mechanical engineering, biology, and landscape design. Each of these students was able to articulate clearly how their new choice of major suited them better. For example, one of these students highlighted ethical concerns related to the necessity of animal trials in the FDA approval process, alongside a realization of the student's desire to work outdoors. Another student decided that the amount of mathematics in BME was more than the student wanted to do. Although this is traditionally seen as attrition or failure of retention, our program has convinced university administrators to only count students who leave the university entirely as a failure of retention. Because we are finding that so many students enter BME with unrealistic expectations, we (and now our university administrators) consider it success to help students either adapt their expectations to match what BME offers or to find a new program of study that better matches their expectations. As long as this is done early and helps the student successfully graduate from his/her new degree program, we and the university consider that a success.

A related question in the Fall 2016 survey was "I am confident that BME is the right choice of major for me." At the beginning of the semester, approximately 79% of students answered "agree" or "strongly agree" to that statement, with only 7.6% answering "disagree" or "strongly disagree". At the end of the semester, the "agree" or "strongly agree" group had decreased to 50%, and the "disagree" or "strongly disagree" group increased to 35%. Of note, for our co-taught section, at the beginning of the semester, 2/19 neither agreed nor disagreed with the statement. By the end of the semester, none of our students answered that way – all either agreed / strongly agreed or disagreed / strongly disagreed. For other sections of the course, approximately 17% of students (7/41) answered "neither agree nor disagree" at the end of the semester. Based on this observation, we propose that the information and reflection provided in our co-taught section of the course provides sufficient information for students to decide whether to remain in BME or switch to another major – leaving all students confident that either BME is or is not the right choice of major for them.

2) Understanding career paths for BME graduates

A survey of our alumni conducted in 2007, together with a recent analysis of the *ASU Biomedical Engineering* group on LinkedIn (with 1000+ alumni members), show that the most widely accepted entry-level jobs for graduates exiting our program with a B.S.E. seem to be

quality assurance (QA), regulatory affairs (RA) and technical sales. Following our objective to expose students to realistic career paths in biomedical engineering, jobs mentioned and/or discussed in detail during our course section included QA, RA (alumni presentation, 2016), technical sales (alumni presentation, 2016), supply chain management, patent law (alumni presentation, 2015), medicine (alumni presentation, 2015), and research/academia (faculty presentations in 2015 and 2016). Over both Fall 2015 and Fall 2016 semesters, we observed greater understanding among our students of possible career trajectories for biomedical engineers, as detailed below. The choice of presenters to include alumni who have positions in QA, RA, and technical sales was deliberate because we wanted students to have exposure to these job titles. We hypothesized that having alumni with these jobs would positively influence students' ability to identify these as jobs available with a B.S.E. in BME.

At the end of the course, our students were noticeably stronger in their articulation of the career options available to biomedical engineers graduating with a B.S.E. The initial and final course surveys included the following question: "*Briefly describe what you think a biomedical engineer with a B.S.E. does in their job. (For example, someone 2-3 years after graduating with a B.S.E. in BME).*" In the Fall 2015 pre-course surveys, most students offered very broad and general suggestions of what careers awaited BME graduates, using terms such as 'research' (6/15), 'design' (6/15), solving medical problems (4/15), or helping people/the world (3/15). One student replied "I honestly have no clue." In the final survey for Fall 2015, responses became much more specific: 13 out of 15 students detailed one or more specific career paths pursued by BME graduates with a B.S.E., including quality assurance (11/15), regulatory affairs (10/15), technical sales (5/15), and supply chain management (1/15), and provided short summaries of what these jobs entailed. Only two students did not mention one of these careers: one mentioned 'lab technician', and the other replied "Help in industries. Do paper work." Also, none of the end-of-semester surveys included 'research' as an activity associated with a B.S.E. degree in BME, compared with 6/15 in the initial survey. Furthermore, the use of terms like 'design', 'create', 'develop', and 'solve problems' were no longer being proposed as core activities for someone with a B.S.E. degree in BME.
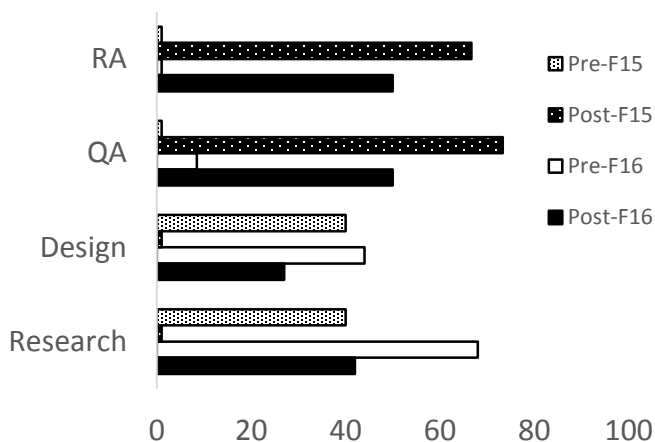

Figure 2. Percentage of students before Fall 2015 (black dots on white background) and Fall 2016 (white) and after Fall 2015 (white dots on black background) and Fall 2016 (black) mentioning RA, QA, Design, or Research in their responses to what graduates with a B.S.E. in BME do 3-5 years after graduation.

We used a similar coding approach to analyzing Fall 2016 survey data. We performed a similar method to that described above – finding themes in these data by writing down key words or phrases from each response. After a few responses, categories of responses emerged, and keywords/phrases from later responses were added to categories when they fit, or became the

first entry in a new category. These categories were used to perform a semi-automated search for key words / phrases in the Fall 2016 responses using the 8 categories detailed in the Methods section. In the Fall 2016 pre-course survey, 68% (80/117) students mentioned 'research', 44% (51/117) mentioned 'design', 20% (23/117) mention helping patients or the world, 9% (11/117) mention solving problems, and 3% (4/117) indicated that they knew too little to answer the question. Ten of the 117 students mentioned quality in a way related to QA positions, and 3/117 mentioned sales. None mentioned "regulatory", "FDA", "supply chain", or anything else that was a recognizable job function for a typical B.S.E. BME graduate. These data are consistent with the responses from our section of students in Fall 2015. Similarly, in our Fall 2016 co-taught section, 68% (13/19) mentioned research, 47% (9/19) mentioned design, 47% (9/19) mentioned helping patients or the world, and only 11% (2/19) mentioned any recognizable job functions for a typical B.S.E. BME graduate.

In the post-course survey, approximately 42% (17/41) still mentioned research, 27% mentioned design (11/41), 10% mentioned helping patients or the world (4/41), and none mentioned solving problems or indicated that they knew too little to answer the question. These are substantial decreases from the pre-course survey, possibly indicating (i) better awareness that a B.S.E. in BME does not typically get hired into a R&D position, or (ii) that students were more able to include specific descriptions and thus eschewed vague descriptions of research or design of medical devices. Post-course survey data indicate that approximately 50% of students (21/41) mentioned quality assurance jobs, 50% (21/41) mentioned regulatory affairs jobs (or mentioned providing data for the FDA), and 22% (9/41) mentioned technical sales. One interesting note is that a higher proportion of students in our co-taught section mentioned regulatory affairs jobs (approximately 70%, 7/10) compared with students in other sections (45%, 14/31). This could be due to having had an alumna working in regulatory affairs present to our section about her job. Another interesting note is that, whereas approximately 25% of students in other sections of the course did not mention any job functions specifically (i.e., they did not mention any of QA, RA, or technical sales), 100% of the students in our co-taught section named at least one of these job functions in answering this question.

By the end of the semester in our co-taught section as well as other professors' sections, students also demonstrated a good understanding what kinds of biomedical engineering jobs require advanced university degrees. Most students were able to calibrate their choice of degree with the career paths they saw for themselves. Within our Fall 2015 student cohort, 11/15 identified a single desired job/next step, while 4 mentioned they were considering more than one option. Our students were diverse in their ambitions, with 3 considering medical training, 3 committed to PhD research, 8 wishing to pursue either a B.S.E. or M.S. in BME in order to enter industry (with the degree depending on the type of industry job), and 2 considering law school or industry. This diversity in student interests suggests to us the importance of discussing a wide range of career options within the course.

In the Fall 2016 pre-course survey, we asked students whether they planned to conduct research after they graduated. In a separate question, we asked whether they planned to pursue a PhD after graduation. Based on findings from our Fall 2015 section, we expected to observe many students indicating that they wished to conduct research but not be aware that they would likely need a PhD in order to pursue a research-oriented career – (see the top middle box or top

right box in Table 1a and 1b – students wishing to conduct research but not indicating they will pursue a PhD).

Table 1. (a) Pre-course (n=117) and (b) post-course (n=42) correlation between research aspirations and indication that the student intends to pursue a PhD.

Pre-course		Pursue PhD?		
		Yes	No	Not sure
Conduct research?	Yes	14%	3%	27%
	No	3%	8%	1%
	Not sure	4%	9%	33%

Post-course		Pursue PhD?		
		Yes	No	Not sure
Conduct research?	Yes	17%	5%	12%
	No	0%	21%	2%
	Not sure	7%	14%	21%

The overall percentage of students wishing to pursue a research-oriented career (answered 'Yes' to whether they planned to do research) decreased over the course of the semester (44% at the outset, 34% at the end of semester). However, in the pre-course survey, 30% of students responded that they wished to pursue a research career but were not intending to pursue a PhD or unsure of whether they would pursue a PhD. By the end of the semester, we saw these responses ('yes' to research, but 'no' or 'not sure' to PhD) decrease to 17% of student respondents, approximately half as many students as in the pre-course survey. The students indicating that they wished to do research and intended to pursue a PhD increased from 14% to 17%, a slight increase. Thus, the most substantial difference from pre-course survey to post-course survey is students who wish to do research realizing that they need to pursue a PhD in order to achieve their career goals. Interesting to note is the 3% of pre-course respondents who indicate that they do not wish to conduct research but intend to pursue a PhD, but this decreased to 0% by the post-course survey seemingly indicating that they feel the only reason to pursue a PhD is if they were interested in a career in research. Future work may follow up on what specific career aspirations these students hold.

3) Linking future aspirations to current actions

As well as demonstrating a clearer understanding of job prospects and an ability to situate their career aspirations within this landscape, our Fall 2015 end-of-course survey indicated student confidence in linking their aspirations to actions they could take at university. Student responses to the open-ended question *"What part of ASU101 was most helpful to you in thinking about*

your plans 3-5 years after graduation? How was this part of ASU101 helpful to you?" identified several course components, including learning about different career options through alumni and faculty presentations (11/15), the time management exercises (2/15), and the visit to the careers center (1/15). Students identified these as useful for reasons including: "It helped me to plan ahead for my next four years here at ASU in terms of my extracurriculars and use of time"; "It opened my eyes to the things I need to start doing now" and, "I need to make sure that I attend career fairs and utilize my career resources to kick start my post-graduation plans."

In the Fall 2016 surveys, we asked students Likert-scale questions regarding their view of the importance of "having a plan of what I need to do to graduate," and how frequently they "set [themselves] clear academic goals." Students indicated that they recognize the importance of having a plan of what they need to do to graduate: approximately 64% (74/115) identified this as 'extremely important', with almost all of the remaining students (32%, 37/115) indicating it as 'important'. However, students admitted that they don't always set themselves clear goals: approximately 38% (44/115) say that they set clear academic goals all of the time, 43% (49/115) say that they do this often, and 17% (20/115) say that they do so sometimes. These percentages do not change much from the pre-course survey to the post-course survey, or from our section to other professors' sections. The percentage of students indicating that goal-setting is extremely important decreases somewhat, and the percentage of students indicating that they always set clear academic goals or do that often decreased somewhat. That students would rate themselves poorer at setting clear academic goals at the end of the semester than the beginning was initially surprising. In grading the final reports of the students in our co-taught section, we observed that several students struggled to set specific, measurable, achievable, realistic, timely (S.M.A.R.T.) goals. It is possible that this decrease in students' self-rating of their frequency of setting clear academic goals could reflect a more realistic appraisal of their behavior than a decrease in ability or motivation to set clear academic goals.

Conclusions and lessons learned

Among students entering our BME program, we find that initial understandings of what industry jobs are available to graduates with a B.S.E. in BME are vague and often somewhat misguided, placing too much emphasis on research and design. In our co-taught section, we see that students seem to develop more realistic expectations about the positions available to them upon graduation, and begin to articulate their personal visions and career aspirations in more concrete terms. Building weekly reflections into the course structure has also encouraged our students to begin formulating specific, immediate actions they can take to work towards their career goals. The tone of students in their end-of-course surveys (Fall 2015) and design projects (Fall 2016) was largely confident and upbeat, conveying enthusiasm for the knowledge they gained; even students switching out of BME indicated that the course had been valuable and enjoyable for them. Based on this, we conclude that helping to set realistic career expectations can be a positive and constructive experience for students in their freshman year.

The success class offered by our BME department receives consistently high ratings from students, and is linked to higher-than-average student retention rates at the university. Our co-taught section requires students to complete additional work not required by most of the other sections, including personal and career reflection exercises, and (in Fall 2016) an end-of-

semester design project. Some students do mention this in their end-of-semester evaluations, but it does not seem to be a major cause of complaint. A noteworthy observation is that students in our section seem to finish the semester with clearer views about whether BME is or is not the right choice of major for them. We believe this to be an important achievement, particularly in the interest of enabling students to graduate on-time if they determine BME is not for them. Anecdotally, we also hear from BME advising staff that students who took our co-taught sections of this success class are typically more prepared for their advising sessions, ask better questions, and set better goals over their undergraduate degrees.

Whether these findings warrant the additional work involved for both instructors and students in our section is an open question. Our students spend an extra 1-2 hours per week on homework for this section compared with most of their colleagues, and the faculty resources involved in arranging for alumni visits, visits to the careers center, and developing and grading weekly student assignments, should not be ignored. It is not clear whether extending the approach we have developed to other student sections will prove feasible. When considering which activities to prioritize, the end-of-semester evaluations for our co-taught section have emphasized that alumni presentations are very valuable in helping students to reflect on their choice of BME as a major, and on future career prospects. We conclude that freshman success courses in BME would benefit from including presentations from recent graduates in entry-level job types available to biomedical engineers. If arranging in-person visits is too difficult, we suggest that asking alumni to submit short videos describing their day-to-day work life and experiences as BME students can be a satisfactory substitute, and one that would permit rolling out to a larger number of students / class sections. Given how many students seem to view good job prospects as forming at least part of their motivation for enrolling in BME, helping them to better understand what those job prospects entail would seem a critical function that a freshman success class can offer.

References

1. Henriette Tolstrup Holmegaard, Lene Møller Madsen, and Lars Ulriksen (2016) "Where is the engineering I applied for? A longitudinal study of students' transition into higher education engineering, and their considerations for staying or leaving." European Journal of Engineering Education, 41(2): 154-171, doi: 10.1080/03043797.2015.1056094

2. Emma K. Frow and Michael R. Caplan (2016) "Work in Progress: Promoting Career Reflection Among Freshman BME Students." Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. doi: 10.18260/p.27026

3. Light, Richard J. How to live wisely. *The New York Times,* 31 July 2015; http://www.nytimes.com/2015/08/02/education/edlife/how-to-live-wisely.html?_r=0 (accessed 28 Jan 2016).

4. Landis, Raymond B. *Studying Engineering: A Road Map to a Rewarding Career* (4th Edition). Discovery Press, Los Angeles, California. 2013.

Appendix. Survey Instrument used for Fall 2016

1. There is no question #1. In the online survey, this question would ask for your consent to participate in the research study. You are not a participant of Drs. Frow's and Caplan's research study, but you wish to complete this alternate assignment to receive the same credit / extra-credit as those students who are participating in the research study.

2. Describe what you think a biomedical engineer with a B.S.E does in their job. (For example, someone 2-3 years after graduating with a B.S.E. in BME)

3. List the kinds of jobs that a graduate with a B.S.E. in Biomedical Engineering could hold within about 5 years after graduating. If you don't know of any, please type "Don't know" in the first row.

4. For each statement, indicate how strongly you disagree or agree with the statement.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am confident that BME is the right choice of major for me					
An engineering degree will guarantee me a job when I graduate					
Biomedical engineers work directly with patients to help solve medical problems					
Biomedical engineers contribute to making the world a better place					
My primary motivation for choosing engineering is the solid job prospects for engineering graduates					

I am interested in creating new solutions to previously unsolved medical problems					
I am comfortable describing what a Quality Assurance position involves					
I am comfortable describing what Regulatory Affairs position involves					
I am comfortable describing what Technical Sales position involves					
Anyone who starts off as an engineering major has the ability to graduate in engineering					
Being very busy often causes me to do poorly on assignments and/or tests					
I prefer to solve difficulties on my own, without seeking help from others					
When I do not do well on an assignment or test, it is usually my fault					
Teachers' inability to explain topics/instructions often causes me to do poorly on assignments and/or tests					

5. After graduating with my B.S.E., I plan to:

	Yes	Not sure	No
Study for a M.S. (Masters)			
Study for a PhD (Doctorate)			
Get a job in industry			
Get a job other than in the biomedical engineering field			
Attend medical school			
Attend law school			
Do research			
Start my own business			

6. Please provide some additional information about your plans after graduating.
   a. If you plan to get a job in the BME industry, what type of job do you hope to get?
      (skip if you do not wish to get a job in the BME industry)

   b. If you plan to get a job in a field other than BME, what type of job do you hope to get?
      (skip if you do not wish to get a job in a field other than BME)

   c. If you plan to do research, on what topic do you intend to do research?
      (skip if you do not wish to get a job in research)

   d. In the short term (1-3 years after graduating), my career aspirations are:

e. In the longer term, my career aspirations are:

7. Please indicate how important the following items are to you and your success at ASU.

	Not at all important	Unimportant	Neither important nor unimportant	Important	Extremely important
Having a plan of what I need to do to graduate					
Having positive interactions with my professors					
Engaging in group study and collaborative learning with my peers					
Feeling a part of the academic community at ASU and the FSE					
Campus resources such as the writing center, library, etc.					
Spending time on campus, for both curricular and extra-curricular activities					
My own drive and motivation to obtain an engineering degree from ASU					

8. Please indicate how frequently you do the following activities or feel this way about your student experience:

	Never	Rarely	Sometimes	Often	All of the time	Not applicable / do not know
I interact with my professors in the classroom						
I interact with my professors outside of the classroom						
I engage in group study and collaborative learning						
I schedule and manage my time carefully						
I take good notes and practice good studying habits						
I prepare for each class by reviewing my notes, reading ahead, attempting some problems, and/or writing down questions						

I actively practice how to read for comprehension						
I spend as much time on campus as possible						
I set myself clear academic goals						
I effectively manage my personal life including interacting with family and friends, my personal finances, and my outside workload						
I interact with other students in my classes and feel part of an academic learning community						
I make use of campus resources (e.g., tutoring center, library, career center, student services, etc.)						
I feel good about myself and my situation						
I feel confident in my ability to succeed academically						
I feel positive about the educational experience I am receiving at ASU						

9. Please provide your name, ID#, and email address so that we can make sure your ASU101-BME instructor knows that you filled out this survey and can give you appropriate credit / extra-credit.

[You are not a participant in Drs. Frow's and Caplan's research study, and your responses in this survey will not be included in their research study in any way.]

      a. Name:

      b. ASU ID#:

      c. Email address: