Work in Progress: Exit Surveys as a Tool for Continuous Improvement in Biomedical Engineering Education

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Introduction

This Work in Progress paper describes a mixed-methods survey tool used to inform curricular and co-curricular continuous improvements of a Biomedical Engineering (BME) undergraduate program at the University of Texas at Austin to better meet program and student needs [1]. Although this survey is extensive and covers BME education, post-graduation outcomes, professional development, academic advising, belongingness, facilities, accreditation outcomes, student demographics, and program feedback, the scope of this work specifically evaluates results related to those pursuing a path in industry post-graduation and ABET Student Outcomes.

Methods

The survey is created by departmental advising staff in the browser-based survey software Qualtrics and is 112 questions in length. A full list of the survey questions is included in Appendix 1. The survey is distributed to all senior-level undergraduates enrolled in the required final capstone design course and, as such, is called the senior exit survey. The senior exit survey is anonymous and distributed directly to students via email using the Qualtrics direct email distribution function, which ensures each participant has a unique link and cannot submit the survey more than once. Timing of the annual survey deployment is mid-April through the last class day in May to collect as many responses as possible at a point in the year when post-graduation plans are more likely to be secured and that is prior to final grade submission. In order to incentivize responding, two (2) additional percentage points of extra credit are awarded to each student in the final capstone design course if the completion rate of the survey exceeds 90% by the last class day. This incentive has proved successful as the course is graded on an absolute basis with no curve. A 93% average response rate has been achieved since 2017.

Question #25 addresses post-graduation plans. The options provided to students are grouped into three main categories: graduate school (biomedical engineering Master's or PhD program, other field Master's or PhD program); professional school (medical school, law school, other professional school); and industry (biotechnology industry, medical device industry, software industry, other industry, consulting or investment banking, government or nonprofit agency). Additional options outside of these three main categories are offered: post-baccalaureate program; taking some time off; undecided; and other. This paper looks closely at results from respondents who selected any option in the industry category. Note that respondents are able to select more than one answer.

Questions #38 and #40 collect more detailed post-graduation plans within industry and are presented in the results of this work. Question #38 asks, "Have you interviewed for industry positions?" Question #40 is offered to those who selected "yes" as a response to Question #38 and asks, "What did you feel you were lacking in interviews?"

In Questions #98-104, students rate their perceived ability to meet the seven ABET Student Outcomes (SOs) on a scale of 1 (not at all) to 7 (extremely), with an average of 5.0 being the minimum target confidence rating set by the program. The survey responses are an indirect measure of student attainment of the SOs.

Advising staff collect, analyze, and present annual senior exit survey response data to the department chair and appropriate faculty sub-committees: the Undergraduate Curriculum Committee (UGCC) and the Accreditation and Assessment Committee. The UGCC is responsible for the oversight and implementation of the curriculum of the BSBME degree program and the Accreditation and Assessment Committee is responsible for ensuring systematic assessment and improvement processes are completed. The committees and the chair review the data, the committees discuss any areas that need to be addressed, and make a plan for implementing required changes in curriculum or co-curriculum in response.
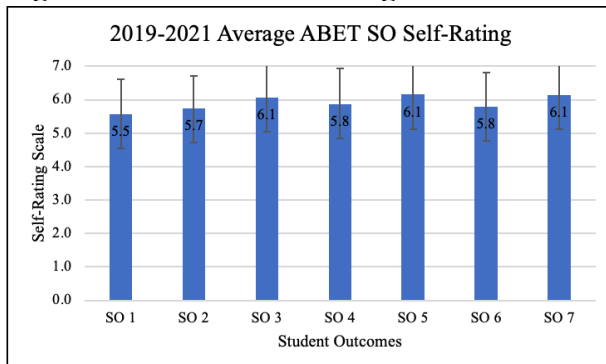
Results

Approximately half of the program's graduating students typically indicate they plan to pursue jobs in industry (Question #25). Of the 2018 respondents who indicated they had interviewed (Question #38), 38% cited technical skills, programming languages, and/or computational skills as what they felt they lacked in interviews (Question #40) (Figure 1.1). In 2019, 50% reported this and in 2020, 48%. In 2021, the percentage went down to 28%.

Figure 1.1 Percentage of Question #40 Respondents that Report Lacking Technical Skills, Programming Languages, and/or Computational Skills in Interviews
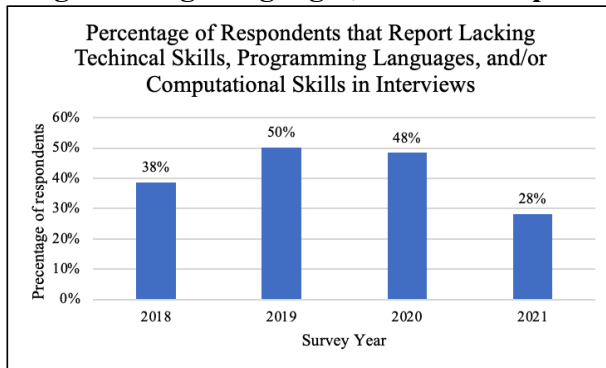
Based on data collected from Questions #98-104, students feel they are meeting and exceeding the minimum target confidence level of 5 (Figure 1.2).

Figure 1.2 2019-2021 Average ABET SO Self-Rating

Limitations

Allowing the selection of more than one answer to Question #25 results in more responses than respondents. Regardless, the program has decided to continue to format the question in this way to avoid placing limitations on students who are considering more than one path at the time of survey completion. In 2018 and beyond, Question #40, "What did you feel you were lacking in interviews?" is limited to those who select one of the options categorized as industry. In 2017, Question #40 was open to all respondents regardless of their answer to Question #25. For the sake of consistency in the data due to the varying display logic of these questions among the survey years, only 2018-2021 data is reviewed here.

ABET updated the SOs from a-k to 1-7 beginning in the 2019-2020 cycle. Because the 2017 and 2018 data reflect SOs a-k, those years are not included in this analysis.

Discussion
The exit survey distributed to all seniors enrolled in the final capstone design course has been an effective tool used to collect data from graduating students over the past five years with an average response rate of 93%.

Question #38 identified a perceived weakness in the program curriculum as students cited technical skills, programming languages, and/or computational skills were lacking in their interviews for jobs. In fall 2018, the UGCC implemented course updates to better prepare students for industry jobs in these areas. Upper-level programming languages and numerical methods immediately applicable in modern industry settings—Python, C++, and MATLAB—replaced a more basic machine learning language in two of the BME degree requirements. One of these two required courses is typically taken in the first year of the program and the other in the second year. The classes of 2019 and 2020 missed the improved version of the two courses so it makes sense that the percentage continued to climb (Figure 1.1). The class of 2021 was the first senior class to experience the improved second year course. The class of 2022 will be the first to experience both improved courses. We expect the percentage of students citing technical skills, programming languages, and/or computational skills as what they felt they lacked in interviews to continue to fall in future years as cohorts experience both of the improved courses. Having the longitudinal data of this survey will help the program determine if the improvements are successful in this endeavor or if more changes need to be considered.

The ABET SOs data (Figure 1.2) reflect in an indirect measure that graduating students are meeting and exceeding the minimum mean target confidence rating of 5. This measure is included in the program's 2022 ABET self-study document that is being prepared for the fall 2022 ABET visit to renew the program's accreditation.

Future Plans
Revisiting data regarding what respondents felt they lacked in interviews led to a closer look at the percentage of students selecting industry as their post-graduation plan and what percentage of those respondents' interview and report receiving and/or accepting a job offer at the time of survey completion. The program plans to evaluate this data in more depth and determine what additional curricular and co-curricular improvements can be made to futher improve employment outcomes. The 2022 survey data will be incorporated and we plan to conduct a more comprehensive evaluation of additional sections of the survey and resulting improvements.

References

1. D. Moore and D. Voltmer, "Continuous monitoring of curriculum via student communications components," 30th Annual Frontiers in Education Conference. Building on A Century of Progress in Engineering Education. Conference Proceedings (IEEE Cat. No.00CH37135), 2000, pp. T4A/12-T4A/17 vol.1, doi: 10.1109/FIE.2000.897654.

Appendix 1 Description of Biomedical Engineering Exit Survey questions

Biomedical Engineering Education
On a scale from 1 (Not at all) to 4 (Very), rate your confidence with the following:
Question 1: I can collect and present data effectively.
Question 2: I have a conceptual and practical understanding of linear algebra & vectors.
Question 3: I understand numerical methods (e.g. finite differences).
Question 4: I can design experiments independently.
Question 5: I can use appropriate statistical methods to analyze data.
Question 6: I can orally communicate results of my work.
Question 7: I can communicate results of my work in written form.
Question 8: I can work effectively with a team.
Question 9: I can design and build a circuit.
Question 10: I understand the signal processing.
Question 11: I can identify the major biomedical imaging modalities.
Question 12: I can effectively use LabVIEW.
Question 13: I am able to solve differential equations using MATLAB.
Question 14: I can design parts using SOLIDWORKS.
Question 15: I can use biomedical measurement tools to collect data.
Question 16: I have a conceptual understanding of biology and physiology.
Question 17: I understand how materials and devices interact with the body.
Question 18: I understand mass, heat, and momentum transport.
Question 19: I can construct a stress strain curve from experimental data.
Question 20: I have a working knowledge of cell culture and cytotoxicity.

Free-text response:
Question 21: Comments or suggestions regarding PEOs

Post-Graduation Outcomes
Multiple Choice Radio Button response:
Question 22: Will you complete your degree in four (4) years?
If "No" is selected for Question 22:
Question 23: How many extra semesters did/will you take to graduate?
Question 24: What were some of the reasons that you did not graduate in four (4) years?

Question 25: What are your post-graduation plans?
If Medical School is selected for Question 25:
Free-text response:
Question 26: If you took the MCAT, what was your total score?

Multiple Choice Radio Button response:
Question 27: To which Texas Medical Schools, if any, were you offered admission?
Free-text response:
Question 28: To which out of state Medical Schools, if any, were you

offered admission?

Question 29: Two which Medical School, if any, are you planning to attend?

Question 30: Do you have any further comments or suggestions for the BME department for pre-medical students?

If Master's or PhD is selected for Question 25:

Free-text response:

Question 31: If you took the GRE, what were your scores?

Question 32: To which programs, if any, were you offered admission?

Question 33: In which program, if any, are you planning to enroll?

Question 34: Do you have any further comments or suggestions for the BME department regarding your preparation to apply to graduate programs?

If Industry is selected for Question 25:

Multiple Choice Radio Button response:

Question 35: What resources have you been using to apply for jobs?

Free-text response:

Question 36: Approximately how many jobs have you applied for to date?

Question 37: When did you start applying for full-time jobs to begin after graduation?

Multiple Choice Radio Button response:

Question 38: Have you interviewed for industry positions?

If 'Yes' is selected for Question 38:

Free-text response:

Question 39: What made you stand out in interviews?

Question 40: What did you feel you were lacking in interviews?

Question 41: Have you received and accepted a job offer to date?

If 'Received but not yet accepted' or 'Not received' is selected for Question 41:

Free-text response:

Question 42: At what companies are you hoping to be hired?

If 'Received but not yet accepted' or 'Received and accepted' is selected for Question 41:

Free-text response:

Question 43: At what companies have you received an offer, and for what job titles?

If 'Received and accepted' is selected for Question 41:

Free-text response:

Question 44: At what companies have you accepted an

offer, and what is your job title?

Multiple Choice Radio Button response:
> Question 45: How did you hear about this specific job or opportunity?

Free-text response:
> Question 46: If ECAC helped you find this job, please comment on the services that helped most.
>
> Question 47: Do you have any further comments or suggestions for the BME department for job searches?

Professional Development

Multiple Choice Radio Button response:
Question 48: I participated in at least one internship.
> <u>If 'Yes' is selected for Question 48:</u>
> *Multiple Choice Radio Button response:*
> > Question 49: How did you find your internship?

Question 50: I participated in a co-op experience program.
> <u>If 'Yes' is selected for Question 50:</u>
> *Free-text response:*
> > Question 51: Where did you do your co-op experience?

Question 52: I participated in study abroad.
> <u>If 'Yes' is selected for Question 52:</u>
> *Free-text response:*
> > Question 53: Where did you study abroad? How was this experience?

Question 54: I participated in undergraduate research with a faculty member for at least one semester.

Question 55: Please select all of the BME workshops you attended at least once.
> <u>If one of the workshops was selected for Question 55:</u>
> *Free-text response:*
> > Question 56: Please share how the workshop(s) were or were not helpful to you so we can improve them. Are there other topics we should cover in workshops?

Question 57: Did you use the ECAC's services during your time as an undergraduate?
> <u>If "Yes" is selected for Question 57:</u>
> *Free-text response:*
> > Question 58: Was ECAC helpful in finding a BME job, internship or other BME career opportunity? Why or why not?
> >
> > Question 59: What were your career goals when you started in the BME

program?

Question 60: Did your career goals change? If so, when did they change, and how are they different now?

Question 61: When you applied for college, to what other undergraduate BME programs were you offered admission?

Question 62: Why did you choose UT Austin BME?

Academic Advising

On a scale of 1 (Strongly Disagree) to 5 (Strongly Agree), rate your level of agreement:

Question 63: The advisors helped me make decisions about what classes to take and when.

Question 64: The advisors provided clear instructions for registration and completing my degree.

Question 65: The advisors provided registration information in a timely manner.

Question 66: The advisors provided information about research and internship opportunities.

Question 67: The advisors provided information about career paths.

Question 68: I felt supported by my advisors.

Question 69: I am comfortable contacting the advisors with questions.

Question 70: I am comfortable navigating resources on the Advising Canvas page on Box.

Multiple Choice Radio Button response:

Question 71: I have contacted the BME advisors for help when I needed it.

Question 72: I felt comfortable asking the advisors questions.

Question 73: I knew where to go to schedule 1:1 tutoring appointments or attend drop-in tutoring.

Question 74: I knew where to go to find things like my degree requirements and the lists of technical electives.

Free-text response:

Question 75: Please provide any additional comments you have on academic advising in BME.

Question 76: If you found other student services helpful, please list them here.

Belongingness

On a scale of 1 (Strongly Disagree) to 5 (Strongly Agree), rate your level of agreement:

Question 77: I feel like a real part of the BME program.

Question 78: It's easy for people like me to be accepted here.

Question 79: I feel comfortable asking a question in class.

Question 80: I discuss course material with my classmates before or after a class.

Question 81: I feel comfortable volunteering ideas or opinions in class.

Question 82: Speaking in class is easy because I feel comfortable.

Question 83: Class sizes are so large I feel like a number.

Question 84: I like knowing people in my classes.

Question 85: I know students who could help me with a course if I need it.

Question 86: I participate in study groups with other students.
Question 87: I feel comfortable asking a professor or TA for help if I do not understand the course material.
Question 88: I feel comfortable emailing a professor or attending office hours.
Question 89: Faculty here generally care about students.

Free-text response:
Question 90: Please provide any additional comments about your experience in the BME community.

Facilities
On a scale of 1 (Strongly Disagree) to 5 (Strongly Agree), rate your level of agreement:
Question 91: The labs and equipment were well maintained.
Question 92: I had access to the equipment materials I needed.
Question 93: I had access to maker space.
Question 94: There was suitable study areas in and near the BME Building.
Question 95: The BME facilities suited my needs overall.

Free-text response:
Question 96: Please provide any other comments you have on the BME facilities.

Accreditation Outcomes
Multiple Choice Radio Button response:
Question 97: Please rate your satisfaction with these identified objectives for our degree holders following graduation and during the first several post-graduate years.

On a scale of 1 (Not at all) to 7 (Extremely), rate the degree to which you agree with the following statements:
Question 98: I have the ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (ABET SO 1)
Question 99: I have the ability to apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, as well as global, cultural, societal, environmental, and economic factors. (ABET SO 2)
Question 100: I have the an ability to communicate effectively with a range of audiences. (ABET SO 3)
Question 101: I have the ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (ABET SO 4)
Question 102: I have the ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (ABET SO 5)

Question 103: I have the ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions. (ABET SO 6)

Question 104: I have the ability to acquire and apply new knowledge as needed, using appropriate learning strategies. (ABET SO 7)

Student Demographics

Multiple Choice Radio Button response:

Question 105: How do you identify your gender?

Question 106: Ethnicity

Question 107: Race

Question 108: Voluntary Self-Identification of Disability

Program Feedback

Multiple Choice Radio Button response:

Question 109: Which technical area did you pursue for your BME degree?

Free-text response:

Question 110: What do you think are the strengths of the BME program?

Question 111: What do you think are the areas in the BME program that need improvement?

Question 112: Please provide any general comments or feedback you have here.