

Engineering Graduates' Assessment of Academic Preparation for Next Steps

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Abstract - The recent interest in academic accountability – do engineering programs deliver the best preparation possible for graduates entering the profession – has engineering faculty and administrators looking at a variety of assessment strategies. Exit and post graduation surveys are two sources of data about the quality and relevance of these programs. How well do graduating seniors and alumni think their degree programs prepared them for their next steps, careers or graduate studies? This paper, a collaboration between an engineering department and an education school at a large research university in the United States, investigates the answer to that question and offers a reproducible model with lessons learned. The population for the study is biomedical engineering graduates who have had National Science Foundation (NSF) funded Biomimetic Research Center activities integrated into their overall program offerings. The first phase of this study reports on 130 exit and post graduation surveys collected between 2006 and 2007. That phase reflects a 68% response rate from a surveyed population of 190 graduates and alumni. The surveys utilize both selected response and open-ended questions. Preliminary findings suggest students' positive reception of applied courses and program and career advisement and concerns over courses offerings and specialized selection opportunities.

Index Terms – alumni feedback, biomedical, ERC, program assessment.

INTRODUCTION

In a seminal 2005 report on the need to adapt engineering higher education to the new century, the National Academy of Engineering asks the overarching question, “What should engineering education be like today, or in the near future, to prepare the next generation for effective engagement in the engineering profession in 2020?” [1]. The report notes that meaningful energizing experiences are most likely to provide the impetus for students who wish to continue their education and/or contribute to their engineering field of expertise in the workforce. Because of the rapid changes in technology and the economy and because of social and political forces worldwide, educators are preparing students

for jobs that do not yet exist. It is imperative that students come away from their education with a core knowledge base, professional skills, and an understanding of the vital need for lifelong learning [2]. Wormley, the current President of American Society for Engineering Education (ASEE), summed up the need by stating “engineering education must prepare graduates to: (1) practice in the global environment, (2) be flexible, agile, and innovative, (3) communicate clearly, understand teamwork, and (4) be aware of cultural differences, and be solidly grounded in fundamentals and have a broad base” [3].

In order to answer the question, “do engineering programs deliver the best preparation possible for graduates entering the profession or graduate studies?” engineering faculty and administrators have sought out a variety of assessment strategies for data. Examining preparedness from the viewpoint of graduating seniors and alumni from engineering programs are two sources of viable data. How well do alumni think their degree programs prepared them for their careers or advanced degrees? If not well, what do they think was missing? In what ways were the programs successful? Finally, when we get useful feedback from our graduates, how do we translate it into programmatic change?

This paper reports on a study of graduating biomedical baccalaureate and master's degree students and alumni who are now working in the profession or continuing their studies in advanced degree programs. The graduates were asked their perceptions of preparedness for their next steps, employment in the profession or graduate studies. The population for the study is biomedical engineering graduates who have had National Science Foundation (NSF) funded Biomimetic Research Center (BMES-ERC) activities integrated into their overall program offerings. The coursework and research of the BMES-ERC focuses on the use of non-biological materials to replicate biological functions such as sight, memory, and mobility.

This assessment will be used to inform educational practices of a research university's biomedical engineering degree programs and the ERC projects. The on-going investigation takes place as part of a collaboration between biomedical engineering and ERC faculty and staff at the USC Viterbi School of Engineering and educational researchers from USC Rossier School of Education. The engineering faculty and staff lend their expertise of field-

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specific programs and practices while the educational researchers provide their knowledge of student learning outcomes and program assessment.

In addition to garnering knowledge from graduates' feedback in a specialized engineering program, this paper provides a critical look at the methodology used so that other institutions considering a study of graduate and alumni perceptions can benefit from the "lessons learned." The paper discusses the teamwork approach to inquiry and the steps identified to proceed with the research. The steps included assessing what data are needed, the "when" and "how to" of contacting graduating students and alumni, the types of questions that yielded the most useful information and the importance of social networking..

RESEARCH ON GRADUATES AND ALUMNI INFORMING PROGRAM PRACTICE

There is a substantial body of literature that documents the utility of alumni input in higher education research on perceived institutional quality and student outcomes [4]. Graduates' perceptions of how well their institutions prepared them for practice have been frequently used to influence institutional curriculum, student services and faculty practices [5]. The merits of using alumni input derive from the assertion that graduates can measure the extent to which the institution prepared them for employment or future educational interests [6]. Whereas alumni input has been widely used to measure the quality of education administration and business programs, few studies have focused alumni input on engineering programs. Noting this, the school of education at one research institution in collaboration with the school of engineering at the same institution developed a plan to use feedback from graduating biomedical degree students and alumni. The question they wished to answer was "how do graduating biomedical degree students and alumni perceive academic preparation for employment in the profession or advanced degrees?" The findings from this formative evaluation will be used to inform future program practice.

FORMATIVE ASSESSMENT PLAN

The research that was done for the biomedical engineering and ERC program served as a part of a larger formative evaluation study. A key assumption of a formative evaluation is "that people can and will use information to improve what they are doing" [7]. The purposeful sample was comprised of graduating biomedical degree students who have plans to begin work in the profession or to pursue advanced degrees. The graduates were surveyed using an instrument that had both selected response questions and open-ended questions. They were asked their perceptions of whether or not their academic preparation within the specialized biomedical engineering and ERC program had adequately prepared them for employment or advanced degrees. If they found the preparation lacking, they were asked to make recommendations for program improvement. One year later, alumni from this same program responded to

an expanded version of the exit survey they had completed prior to graduation.

USING A SURVEY AS A METHOD OF EVALUATION

The increasing interest in program assessment across higher education institutions in the United States has resulted in the use of a variety of instruments to evaluate program quality [8]. Its ability to cover factual and subjective topics, economical implementation and fast data collection has made the survey a popular instrument in higher education [9]. Higher education researchers and accrediting bodies have recognized that surveys are the only practical source of descriptive information [9]. On-line surveys have the added benefits of large and distant populations, easy access, verifiable delivery, and easy-to-use analysis tools [10].

This study used data derived from selected response and open-ended questions that was administered through Survey Monkey, a web-based survey management program. Two types of surveys were used for study. The first survey type was a *BME Graduate Exit Survey* administered three weeks before graduation. This survey was completed in year one, (2006) by the undergraduate biomedical degree graduates only. There were 53 undergraduate surveys administered and 38 respondents (a 72% response rate). Year two, (2007) the population was expanded to both the baccalaureate and master's degree candidates. Fifty-six graduating baccalaureates received the survey, and 39 responded (a 69% response rate) and 53 master's level graduates received the exit survey with 28 respondents (a 72% response rate). Year two, (2007) the survey was slightly revised to include input regarding out-of-classroom experiences in addition to in-class and lab experiences.

The second survey type was a *BME Post Graduation Alumni Survey* of alumni currently working in the profession or pursuing advanced degrees. The second survey was administered one year after graduates received their baccalaureate. There were 41 BME Post Graduation Alumni Surveys sent out with 26 alumni responding (a 63% response rate).

I. BME Graduate Exit Survey

The BME Graduate Exit Survey provided the research team with several different types of important information including:

- overall satisfaction with the program
- overall satisfaction with individual courses
- next step plans, employment or pursuit of an advanced degree
- if employment, type, and where
- if advanced degree, type and location
- recommendations for program improvement.

Input on the exit survey protocol was provided by the educational research team but was administered by program advisors. It is likely that the high response rate was attributed to the students' replying to a request from someone in the department that they knew well. Because the exit survey was not anonymous, it provided researchers the ability to receive future, non-university contact information from the

participants. The contact information will be used the following year for their reflections on program effectiveness after experiencing the workforce or an advanced degree program. It is possible that the lack of anonymity may have restricted their range of answers to the open-ended survey questions.

II. BME Post Graduation Alumni Survey

The educational research team developed a follow-up survey to distribute to alumni of undergraduate and graduate programs who have taken positions in the profession or who are pursuing advanced degrees. The BME Post Graduation Alumni Survey was an expanded version of the BME Graduate Exit Survey. The follow-up survey included selected-response and open-ended questions. The selected-response items had survey logic built-in to direct respondents to the appropriate open-ended items in the survey. Graduates were asked questions about their academic experiences in and out of the classroom as the experiences related to the graduates' current position or advanced degree attainment. Other points of inquiry included the quality of interactions with department faculty and staff, and the overall strengths and weaknesses of the programs. Table I lists sample questions used in the survey.

TABLE I
SAMPLE BME POST GRADUATION ALUMNI SURVEY ITEMS

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1. What degree did you most recently receive?
 2. Will you begin employment in the profession or pursue an advanced degree?
 3. In what ways were your classroom and / or lab experiences helpful in preparing you for your job or graduate studies?
 4. In what ways could your classroom and / or lab experiences have been improved to better prepare you for your current employment or graduate program?
 5. How helpful were the research, internship, and volunteer experiences sponsored by the BMES-ERC?
 6. How helpful was your academic advisor in providing information that proved useful for your job or graduate studies?
 7. Any suggestions for strengthening the BME program for future students?
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One year after the 2006 BME Graduate Exit Survey, the BME Post Graduation Alumni Survey was sent out to the same population. The team had access to 41 non-university email addresses of the original population. The survey was anonymous, which allowed respondents to reply candidly without fear of identification. Respondents were asked if they would like to receive survey results and if so they could provide a preferred contact email. One fourth of the 28 respondents chose that option. The survey was sent out by the educational researchers. The alumni were not familiar with the educational researchers. Although there was a cover letter with a cc to the biomedical engineering program chair, a name they did know, it is possible that the lower response (63% compared to earlier response rates of 72%) was due to the lack of connection to the researchers. It is also possible that the earlier response rates were due to the "captive audience" of reaching those who had not yet graduated.

FINDINGS

The purpose of the study was to determine how well alumni think their degree programs prepared them for their careers or advanced degrees. The findings are aggregated from four different input sources. This includes two undergraduates exit surveys 2006 and 2007, one master's degree exit survey and one alumni survey totally 130 survey responses over one program year. The findings can be broken down into the following theme areas: employment, advanced degrees, out-of-classroom experiences, and course effectiveness.

I. Employment and Preparedness

The 2006 and 2007 BME Graduate Exit Survey for undergraduates reported 13 of the total 77 respondents for the two years reported positions with companies that work with biomedical surgical devices, biotechnology and aerospace. This reflects the students who reported securing a position before graduation. The remainder of the population was still "waiting to hear," "waiting to decide" or "planning graduate school." In 2007, this population was asked how well they felt that they were prepared for the employment. Their responses were as follows: 58% (7 graduates) answered "very well" and 46% (6 graduates) replied "somewhat." This was a total of 13 students. It is interesting to note that 14 different students rated their preparedness for advanced degrees at a higher level than the employed students rated their preparedness for employment. Eighty-two percent (14 graduates) described their preparedness for advanced degrees as "outstanding" or "very well." The figures suggest (at least at the time of the exit survey) that the confidence level for preparedness for advanced degrees is higher than the confidence level for preparedness for employment in the profession.

In the 2007 BME Post Graduation Alumni Survey seven of the 28 alumni reported professional post graduation positions. They described the type of work that their company did as manufacturer of medical devices (N=2), biotechnology (N=2), pharmaceuticals (N=1) and medical research and rehabilitation medicine (N=1), and environmental engineering (N=1). When alumni from this surveyed group were asked how they would describe their preparedness for employment or working on an advanced degree, they provided their perceptions in contrasting ways such as, "by giving me a technical thinking background" or "I learned how to problem solve." Another respondent stated "None...I never had another chance to work with the type of educational material I learned during my BME degree." More than half of the 28 alumni answered this question and 86% (12 alumni) were pleased with their preparation and 14% (2 alumni) registered concerns.

When asked about how well their graduate education had prepared them for industry, 20 master's level graduating students responded as follows: two indicated "Outstanding," nine marked they were "Very well" prepared, six disclosed their preparation was "Good," and three indicated their preparation for work was "Fair." What is not known is if these master-level students took their undergraduate course work at the same institution or elsewhere.

II. Advanced Degree Preparedness

The 2007 BME Graduate Exit Survey included the question "In your opinion, how well has your undergraduate program prepared you for advanced degree?" The five level scale for graduates choices were: "Outstanding", "Very Well," "Somewhat," "a Little", and "Not at all." Seventeen respondents to this question, who had previously answered that they planned to go on to an advanced degree, answered as follows: "Outstanding" 12% (two graduates), "Very Well" 71% (12 graduates) and "Somewhat" 17% (3 graduates).

III. Academic Experiences Outside of the Classroom

Three areas are worth noting about academic experiences outside of the classroom; these include program advisement, the student and industry lunch, and research opportunities.

- Program advisement was discussed frequently as responsive and, supportive. In the 2007 BME Graduate Exit Survey 71% of the population (15 graduates of the 21 that responded to this question) chose to comment on advisement and another 10% (4 students) commented positively regarding advisement being very helpful in the "any other comments" section. This is noteworthy because students also mentioned that they had had three different advisors over the course of four years. In comparison to interactions with faculty outside of the classroom, this same group only had three comments (positive) to make (14% versus a total of 81% responses in that category). In the BME Post Graduation Alumni Survey, the students did express the need for pre-medical school advisement. These same instruments reported the need for more career and job placement assistance.
- Another outside-of-the-classroom positive experience widely mentioned by 66% (14 graduates) was the BME student organization industry lunch. All responses were positive, but a few mentioned the need to have more industry represented at the event.
- Research opportunities when mentioned were always highly touted, but there was concern expressed that there were limitations to participate in research.

IV. BME Course Effectiveness

In years 2006 and 2007 graduating students were asked to provide BME course-specific comments. The top four courses commented on in 2006 were Introduction to Biomedical Engineering, Computer Simulation Methods, Control and Communications in the Nervous System Rehabilitation, and Engineering and Statistical Methods in BME. The top four courses commented on 2007 were the same with one exception: whereas in 2006 graduates reflected on the introductory course, in 2007 they commented on the medical products course more often. Salient comments noted included the utility of coursework and labs in providing

- technical thinking background
- statistical methods groundwork

- preparation of the graduate for anatomy exams in medical school
- industry-related skills found in the regulatory class
- ability to do research as an undergraduate
- ability to tie engineering to medicine

One student described his coursework holistically as "No help" saying, "I never had another chance to work with the type of material I learned during my BME degree." When describing an introductory course, one student stated "Introduction to Biomedical Engineering is a very, very interesting class. Class is easy and extremely enjoyable! If you want to know the "state of the art" technology in different aspects of our field, take this. You'll love it!" Another said that the BME introductory course was "too general, not helpful, and did not give a clear picture of the field."

Exit responses for master's-level graduates described their perception of the scarcity of laboratory-based courses and the excess of theoretical courses. They also advised that the program needed to integrate electrical and computer engineering. One student stated that one of the courses in the master's program should be removed because it focused on entirely on research, rather than product development.

LESSONS LEARNED AND RECOMMENDATIONS

The biggest challenge of any study is getting started. Roadblocks may make it easier to assume that the study cannot take place. For example, the educational researchers were initially surprised to find that an up-to-date list of all graduates with current contact information was not readily available. The first step was to start with what was available and grow the list of alumni for future assessment usage. The undergraduate and master's level exit survey was designed with the dual purpose of learning from students' responses while building a viable list of future contact information; thus these surveys were not anonymous. Learning from all biomedical graduates is the goal of the research team, and, although we acknowledge that the needs and concerns might overlap in some ways, we learned that keeping the populations separate first and then comparing outcomes make for clearer methods. A survey management system is an excellent tool. In developing the protocol for the survey it is also important to use separate questions for each response elicited so that it becomes clear what exactly the responder's comments describe. The next task for applied research is to observe program changes informed by inputs and identify if the changes have been successful. This will be the next step in the program assessment.

CONCLUSIONS

The results from the alumni surveys are preliminary and part of a larger, on-going study. The high response rates from graduating students and alumni suggest that an on-line survey instrument effectively gathers factual and attitudinal data. The selected-response items in the surveys allowed for quantitative analyses of the participants' plans. The open-response items provided information in the areas of the

perceived value of the courses and strengths and weaknesses of the programs.

Most graduating students and alumni in the sample had well-defined career and educational plans. The majority of master-level graduating students planned to join the workforce, while approximately one-third of the undergraduate respondents planned to do the same. More than half of the undergraduate and graduate students and alumni perceived that they were very well prepared for work. The undergraduate participants indicated that they felt very well prepared to take on graduate studies. A smaller proportion of the graduate sample that planned to pursue doctorate degrees felt prepared for their next step.

ACKNOWLEDGMENT

The authors wish to express their appreciation to National Science Foundation (EEC-0310723) for providing partial funding for this research, to the school of education and school of engineering collaborative and to the biomedical engineering graduates who offered their input to inform ongoing program quality for those who follow.

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