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Novel Clinical Needs Finding Course Brings Biomedical Engineering Students Together with Regional Medical Campus Students, Residents, and Faculty to Solve Real-World Problems

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Abstract

Biomedical engineering is the fastest growing engineering field in the United States, preparing a generation of skilled problem-solvers who, together with healthcare professionals, drive the momentum of novel technologies for the prevention, detection, treatment, and monitoring of disease. It is important to the education of biomedical engineers that the dialogue between healthcare professionals and schools of engineering is seamless, constant, and interactive. Lack of sustainable discourse between those who produce technologies and those who use them could reduce the applicability and relevance of the biomedical engineering education[1,2]. Reciprocally, for healthcare professionals to optimally harness the expertise of their engineering colleagues, a direct interaction is required.

The department of Biomedical Engineering (BMEG) is one of the largest departments within the College of Engineering at the University of Arkansas, with approximately 70 students graduating annually. Established in 2012 as the first and only biomedical engineering program in the state of Arkansas, the department is establishing itself as one of the premier research departments on campus. The department prides itself in its commitment to diversity and has been successful in attracting diverse groups of students to enter the field of science and engineering. In spring of 2018, the BMEG undergraduate student body had the highest percentage of female and underrepresented minorities within the college of engineering: 53% female and 37% minority.

The University of Arkansas for Medical Sciences (UAMS) is the only allopathic medical school in the state of Arkansas. In 2007, UAMS established UAMS-Northwest as a regional campus in Fayetteville. UAMS-Northwest extends UAMS' medical education, research, and clinical mission. UAMS-Northwest has approximately 250 students in the colleges of medicine, nursing, pharmacy, and health professions, as well as 48 family medicine and internal medicine residents. UAMS-Northwest is located more than 200 miles from the main UAMS campus in Little Rock but is only one mile from Arkansas' land grant university, the University of Arkansas. The proximity of the regional medical campus to the land grant university provides opportunities for collaboration that can benefit the students of both institutions. This article provides an overview of the implementation and preliminary assessment of a novel Clinical Needs Finding course that was recently instituted as a collaboration between the Department of Biomedical Engineering and the University of Arkansas for Medical Sciences– Northwest Campus.

Course Background

The "crown jewel" of any undergraduate engineering degree is a Senior Design Capstone Project that is carried out during the last year of the biomedical engineering education. During this two-semester course, engineering students work in small groups to produce a prototype of a medical device or process improvement. Traditionally, most Senior Design Capstone Projects are faculty-led, with faculty presenting students with an array

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of projects to choose from. The Department of Biomedical Engineering at the University of Arkansas was committed to transforming the Senior Design Project course to a student-led, real-world problem-solving, interactive course conducted under the mentorship of local healthcare professionals and biomedical engineering faculty. Thus, the Clinical Needs Finding course was instituted as a prerequisite to the Senior Design Project, with the goal of fostering innovation and product development that is directly relevant to local healthcare professionals and patients.

In spring of 2018, the Biomedical Engineering department at the University of Arkansas, in collaboration with UAMS-Northwest launched the Clinical Needs Finding to junior level engineering students. This course provided a cohort of biomedical engineering students the opportunity to observe the operations of clinics on the regional medical campus while interacting with healthcare professionals and regional campus students and residents. The course also required engineering students to develop a project idea to improve patient care. This pilot course consisted of 16 students who participated in clinical observations and discussions on the regional campus. The clinical settings included physical and occupational therapy, family medicine, internal medicine, orthopedics, and a free clinic led by interprofessional students.

Student Preparation

Prior to attending clinical observations, all students attended a Health Insurance Portability and Accountability Act (HIPAA) training administered by UAMS, signed a Confidentiality Agreement, and completed the course for Human Subject Protection Training of the Collaborative Institutional Training Initiative (CITI) for Biomedical Research Investigators. During the course, the students attended lectures that discussed the sustainability, bioethics, and healthcare economics behind innovations and technology. Furthermore, the basics within medical device regulatory environment were covered.

Clinical Observations

Partnering clinics included physical and occupational therapy, family medicine, internal medicine, orthopedics, and a free clinic led by interprofessional students. The pilot course consisted of 16 students who attended 47 observations (each four hours long). In clinics, engineering students shadowed regional campus students, residents, and faculty from the fields of medicine, nursing, pharmacy, and physical and occupational therapy. All engineering students wore photo-identification badges, and all patients were asked to verbally consent to having an engineering student present prior to any encounter. Students were encouraged to interact with all professionals, patients, and caregivers in order to obtain a well-rounded understanding of the operation of the clinic from as many perspectives as possible.

Course Deliverables

As a course mid-term deliverable, each student presented a preliminary project idea based on their clinical observations and discussions with healthcare professionals. All ideas were vetted by engineering faculty and healthcare professionals at the regional medical campus. The most promising ideas were chosen to be developed further, and teams of 2 to 4 students were assigned to each idea. As a final course deliverable, student teams presented design briefs of each selected project. From the pilot course, 4 ideas were accepted as Senior Design projects for the 2018-2019 academic year: these included a grip-strength measuring pen and a mobile knee-block in collaboration with regional campus students and faculty from the College of Health Professions (occupational and in physical therapy); and an automatic pill dispenser and electrocardiogram signal filter in collaboration with regional campus students, residents, and faculty in the College of Medicine and College of Pharmacy. Clinical collaborators were invited to all student presentations, and reviewed the materials students turned in as their course assignments.

Engineering Student Feedback

At the end of the course, engineering students answered a survey about their experiences, and the vast majority provided extremely positive feedback (Figure 1). Some qualitative responses included:

"My observations were both enlightening and educational. It allowed us to see the applications and uses behind the products that Biomedical Engineers make. This concept can be lost during one's education, but this experience brought the purpose behind Biomedical Engineering to life."

"Part of our job as biomedical engineers is to utilize our engineering skills in order to optimize healthcare delivery in clinical setting. To develop useful engineering products, clinical observation is important to find what physicians need to better do their jobs."

"My observations inspired me to include the first and most important value of this project: making the technologies available to the general population. Many times, we forget that the people who are being charged extremely high prices are the ones who need help the most. I realized that the products developed for my project have to be relatively simple and inexpensive to make, available for a wide range of procedures, and provide an alternative to the preexisting methods."

"I think this course has been the most valuable biomedical engineering class I have taken thus far. I

loved being able to engage in my community and help them with their needs. All I would change is to make some more lectures about the design process."

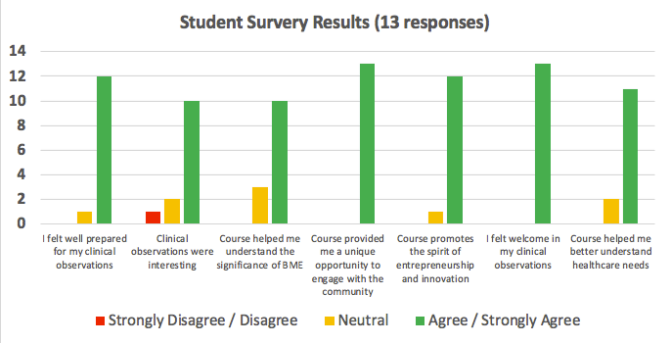

Figure 1. Responses to student questionnaire about Clinical Needs Finding and Observations course in spring 2018 (BME = biomedical engineering)

Clinical Students, Residents, and Faculty Feedback

At the end of the semester, students, residents, and faculty from UAMS-Northwest clinics gave positive feedback about their experiences. Engineering students were seen as professional, respectful, and unobtrusive to the flow of providing care in clinics. Clinical students, residents, and faculty stated that the course "helped them think about possible engineering solutions to patients' health problems." Clinical students, residents, and faculty also expressed a desire to continue to be involved with the projects as they progress through development and possible testing.

Future Directions

The Clinical Needs Finding course has become a mandatory course for all biomedical engineering students at the University of Arkansas. Future implementations of the course will focus on patients who face significant barriers in healthcare due to cultural differences, financial limitations, or geographic distance to healthcare professionals. Engineering students will be encouraged to work on projects that increase their understanding of ethical design and that have direct impact on local patients with a potential for global applications. The Clinical Needs Finding course will focus on helping students become adaptive experts[3], who possess an understanding about design and commercialization in an engineering context, but are sensitive to aspects beyond science, such as resource-constraints or ethical challenges. The Clinical Needs Finding course builds on studies which indicate that incorporating ethics and adaptive expertise instruction into biomedical engineering programs alongside new scientific content, could be the most beneficial modern addition to students[4]. As projects designs are completed, students, residents, and faculty from the regional medical campus will continue to work with engineering students and faculty to test the designs and publish results.

Conclusions

The implementation of the Clinical Needs Finding course is an example of how regional medical campuses can collaborate with universities in their geographic region for the benefit of learners in both universities and the community. Both engineering and health care learners gained valuable understanding about the role of a biomedical engineer in a clinical care and built a network of peer learners and faculty support. Ultimately, patients will benefit from biomedical engineering and health care programs working together to design real-world solutions to healthcare challenges.

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