Impact and Delivery of an Engineering Service Learning Course in a Remote Environment

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Extended Abstract

Introduction:

Undergraduate engineering curricula typically culminate with a "Capstone Senior Design" course, which integrates much of the engineering topics learned to date in a yearlong experience which addresses a field-specific engineering question. The Department of Biomedical Engineering at the University of Arkansas has recently adopted the Clinical Observations and Needs Finding course - a Junior level course, which incorporates service learning initiatives to identify relevant problems suitable for engineering solutions which can then be pursued in the Senior Design course.

The Clinical Observations course introduces students to the technical, professional, and ethical responsibilities of a biomedical engineer in the context of engineering product design and development. Students engage in team-based projects that they identify after completing clinical rotations in local medical facilities, clinics or hospitals. In the course of these projects, students engage the full scope of the engineering design process, with particular attention to clinical needs finding, problem definition, and preliminary design. Issues related to sustainability, bioethics, and health care economics are emphasized. In addition, students are introduced to the concepts of resource-constraint design, as well as important ethical considerations in the work of a biomedical engineer. Effectively meeting this goals and supporting the Senior Design course was substantially challenged during the COVID-19 pandemic, when much of the course content needed to be disseminated via a remote environment.

Major Results:

Clinical needs projects fuel senior design. Each year approximately 35-40 design project concepts are developed by student teams during clinical needs. Approximately 10-12 of these projects are selected each year as senior design projects. Rejected ideas are typically not among the best ideas as determined by the instructor, but also may be limited by the scope of the clinical collaborator's contribution and environment as well as the suitability of the projects for senior design (ie to complex or costly). Alternatively, students with the best ideas that are exceptionally novel will often file an invention disclosure, with co-inventor credit. Some notable examples of design projects developed during the Clinical Needs course include:

Case Study #1: A retractable peritoneal dialysis (PD) catheter to provide a more appealing and ergonomic tube design for patients. The product would maintain the function of a normal PD catheter but would include retractable feature, potentially improving patient quality of life and ongoing compliance with dialysis.

Case Study #2*:* A wheelchair sensor system designed to provide a map of pressure distribution, with the potential to reduce the risk of bedsores in non-ambulatory patients. The pressure distribution map will be distributed to the patient and healthcare providers via a Bluetooth connection.

Each year graduating seniors are asked to assess (five point scale) their "ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability" as part of the Department's ABET assessment. We measured a notable increase in the exit interview score following the addition of the Clinical Needs Finding course to the Biomedical Engineering Department's curriculum. Prior to the inclusion of Clinical Needs, students responded with a mean score of 3.7 and 3.9 during academic years 2016-17 and 2017-2018 respectively. Both years scores fell below our ABET target (>4.0) and in part motivated the development of the Clinical Needs course. Encouragingly, students who have completed Clinical Needs (2020 exit interviews) responded with a mean score of 4.3, an increase of 16% over pre Clinical Needs exit interview scores.

This past academic year we were required to deliver the course using an all- remote delivery format in response to the COVID-19 pandemic. To do so, on site clinic visits with local health care providers were largely eliminated. However, because the remote format did not constrain us to local clinic visits we were able to include remote (Zoom) visits with out of state medical device industry partners (NuVasive, Wright Medical). These visits allowed students to interact with working biomedical engineers, something we had not included previously due to a lack of local industry partners. Despite the limited in-person clinical exposure this years Clinical Needs class generated 12 design projects, which is consistent with previous years.

Conclusions:
While the campus will return to in-person instruction this fall we will continue the remote sessions with industry partners. Interactions with both end-user clinicians and product development engineers will provide students with a unique multidisciplinary experience that we believe may fuel better senior design project ideas. Lastly, the quantitative assessment of Clinical Needs, suggest its has a positive impact on student outcomes, but has thus far been limited to a single senior exit interview question. To allow for a finer grained assessment of the course's impact we plan to develop an more detailed assessment that will include both student and senior design instructor feedback as well metrics to assess the impact of the industry interactions.

Keywords
Faculty paper, service learning, senior design

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