BOARD # 16: Equipping Biomedical Engineering Students with User-Centered Design Skills: Insights from a Clinical Immersion Course

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Work In Progress - Equipping Biomedical Engineering Students with User-Centered Design Skills: Insights from a Clinical Immersion Course

Abstract

A major goal of biomedical engineering is the development of novel and innovative medical technology that advances and improves healthcare outcomes. An essential component of medical device design is identifying the clinical needs of patients and healthcare providers and applying engineering solutions to meet these needs. Our biomedical engineering department has developed a clinical and industry immersion course, which exposes students to the environment in which physicians and patients practice and engages students in this needs identification process. To further refine students' understanding of a user-centered approach to needs finding, we have incorporated a Human-Centered Design module at the beginning of this clinical immersion course. This study aimed to determine the impact of this Human Centered Design module on students' perspectives regarding user feedback and the design process during product development. Students enrolled in the course participated in a pre-class survey that quantified their confidence levels throughout various parts of the engineering design process and assessed their understanding of human-centered design concepts. Results displayed high levels of agreement with statements regarding the module's impact on students' understanding of user needs and their unique perspectives (Mean=3.62, based on a five-point Likert scale). Survey feedback also indicated that students felt this module provided practical tools and techniques for conducting user research and gathering insights (Mean=3.66), and 62% reported they planned to incorporate human-centered design into future biomedical engineering projects. Continuing research will assess and refine these results through larger sample sizes and qualitative responses.

Introduction

A number of undergraduate biomedical engineering programs have implemented clinical immersion courses into their curriculum to allow students to observe and interact with physicians and gain an understanding of identifying the clinical needs of patients and providers first-hand. In the classroom, students are taught the technical skills necessary for biomedical device design. Through exposure to real-world clinical experiences, the students have the opportunity to understand how these skills can be translated into solutions to the needs of both healthcare providers and their patients [1-2]. To encourage students to utilize a user-centered approach, our program introduced the concept of human-centered design to students before participating in clinical visits. Human-centered design is an approach that places the user at the center of the design process and prioritizes their needs rather than forcing the user to adapt to the product. It aims to include user feedback throughout the design process to result in a more beneficial product that has a better impact on the users themselves [3-5]. The first step in incorporating this method into the design process is understanding the use environment to refine user needs. Once the users' needs have been outlined, solutions can be developed through an iterative design process. The module introduced in class aimed to educate students on this process and promote its application during their clinical experiences [6-8]. This study aimed to determine the human-centered design module's impact on students' understanding of incorporating user feedback and their perspective on including this in the design process during product development. Students were asked to integrate this approach into their thought process when developing the final project and devise ideas based on the clinical experiences they attended. Incorporating human-centered design techniques pushes students to expand their perspective on the engineering development process and the importance of user feedback.

Methods

A human-centered design module was delivered in lecture format to a Junior-year cohort (n=29) of biomedical engineering students. This module contained several "big picture" elements of how engineering design is driven by customer discovery and empathy, product ideation, and experimentation. These concepts were directly linked to real-world engineering design of medical devices; specifically, an example of a pediatrics-focused MRI system was discussed. A Qualtrics survey was sent out to the students enrolled in the Clinical Observations course, and collected data were used to quantify the impact of this human-centered design module. This survey collected feedback that quantified students' confidence levels throughout different parts of the engineering design process and their understanding of the human-centered design module presented in class. Both quantitative (Five-point Likert-scale) and qualitative (open-response) data were analyzed. Additionally, an assignment was administered to assess students' understanding of human-centered design concepts. Both self-reported and external assessments provided insights into how this module changed students' clinical design research process knowledge. The Institutional Review Board has approved the current study (IRB protocol #: 2209420237).

Results

The total number of individual survey responses was 29. Both self-reported and external assessments provided insights into how this module changed students' understanding of different aspects of the clinical design research process. Overall, survey results indicated high levels of agreement with adding the human-centered design module and its impact on their thought process as engineers. At the beginning of the survey, students were asked to indicate their level of agreement regarding various aspects of the overall engineering design process, such as their ability to provide relevant solutions as an engineer and to create value for a customer. As shown in **Figure 1,** 87% of students reported being confident in their abilities to make something of value for a customer.

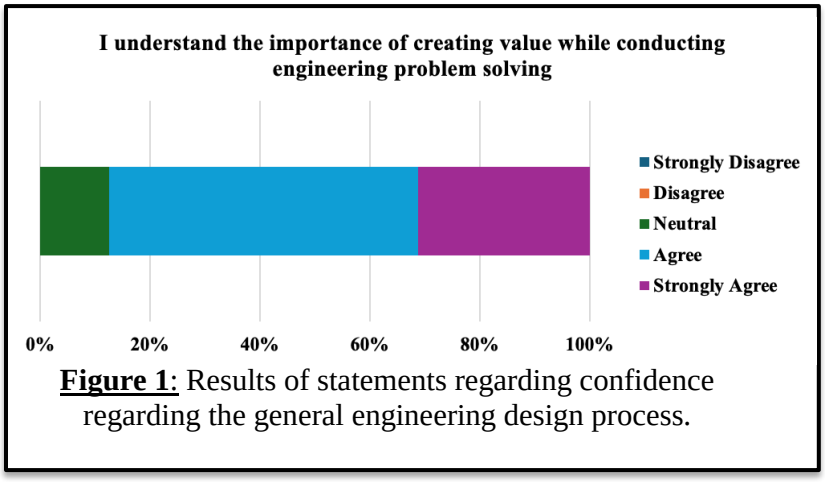

Figure 1: Results of statements regarding confidence regarding the general engineering design process.

The survey quantified students' opinions on the human-centered design module. One of the questions, shown in **Figure 2**, aimed to gauge the understanding students gained when recognizing user needs and perspectives. The chart displays student feedback regarding the impact of human-centered design

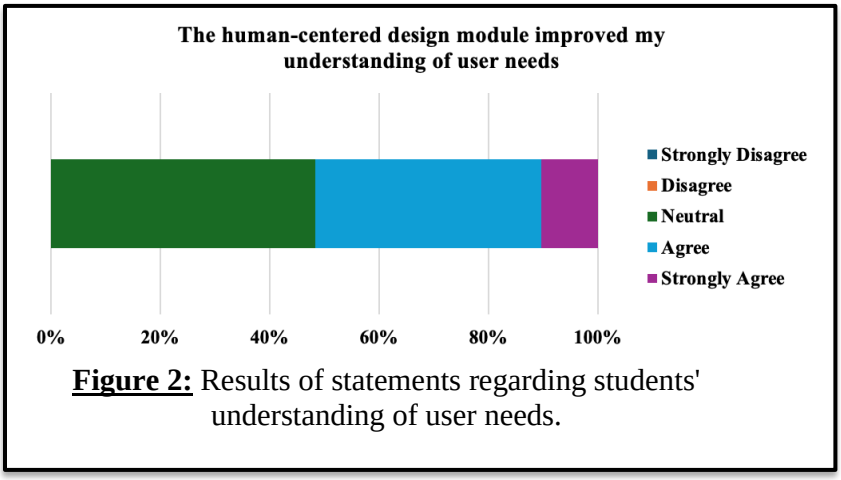

Figure 2: Results of statements regarding students' understanding of user needs.

modules on their understanding of user needs. Students reported moderately high levels of agreement with the statement, with 52% agreeing and the other 48% remaining neutral.

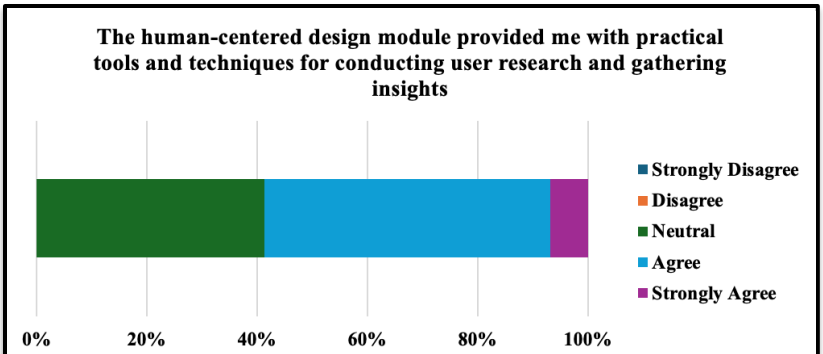

Figure 3: Results of statements regarding the impact of human-centered design modules on engineering design processes.

The survey assessed the impact of the human-centered design module on the students' actual design process. As shown in **Figure 3**, 59% of students indicated that it provided practical tools and techniques for conducting user research and gathering insights. None of the responses indicated disagreement with adding this module, while 41% of students expressed neutrality.

The survey also evaluated the lasting impact of the human-centered design concept on students' engineering design processes. As shown in **Figure 4**, 62% of students reported that this module inspired them to incorporate human-centered design in their future work in biomedical engineering. In comparison, 38% expressed a neutral stance on the matter.

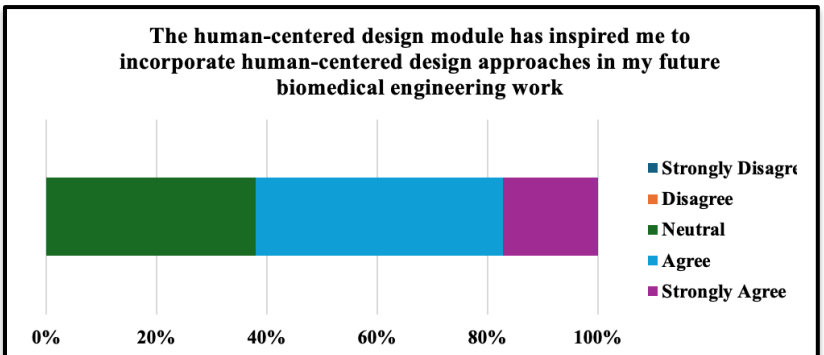

Figure 4: Results regarding the impact the introduction of human-centered design principles had on students for future biomedical engineering projects.

Conclusion:

Overall, the results of this work-in-progress study indicate the general efficacy of incorporating human-centered design principles into a clinical immersion course. This is demonstrated by the 62% agreement rate that the module has inspired students to include this approach in future work, as well as the 59% of students who felt the module provided valuable tools for conducting user research. This study included some important limitations, such as sample size and the lack of a direct control group. Future cohorts of the clinical immersion class will continue to receive the human-centered design content and associated survey used in this study; this will increase sample size by n=25 to n=35 each semester. Since all students in the department will receive this lecture, it is difficult to build a meaningful control cohort. However, as sample size increases, direct comparisons to other departments' clinical observation curricula may become possible, which would improve the ability to assess the impact of these concepts on biomedical engineering students. Longer-term future studies will more directly take a holistic approach, by examining the type and execution of senior design projects. Currently, about 35% to 45% of Senior Design projects originate from experiences derived from this clinical observations course. Comparison between Senior Design projects that are directly derived from the clinical observations course and other projects not derviced from the course will be used to assess the efficacy of customer discovery and other human-centered design concepts in the biomedical engineering curriculum.

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