Biomedical Stakeholder Café: A People-Centered Approach for the Future of Design Engineering Education

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Abstract

In Fall 2023, a first-of-its-kind student-stakeholder interaction event called the Biomedical Stakeholder Café was run at the University of Waterloo. The goal of the event was to facilitate capstone engineering students connecting with diverse biomedical stakeholders to gain lived experience insight and expertise to inform their final year design projects. This multi-stage event was intentionally designed to address known challenges with student-stakeholder interactions by including capstone team applications, student-stakeholder matching, a preparatory workshop, and finally the student-stakeholder conversations themselves.

This paper presents a foundation for an evidence-based student-stakeholder interaction model that enables students to build needed skills and include stakeholders successfully in their design process by (1) presenting a multi-step student-stakeholder interaction model that addresses identified challenges and (2) provides a preliminary assessment of the interaction model based on event organizer, stakeholder, and student perceptions. Using this model, 23 capstone teams across four programs at the University of Waterloo connected with 18 diverse biomedical stakeholders. In total, 44 conversations occurred during the Biomedical Stakeholder Café with each capstone team having one to three stakeholder conversations. The stakeholders represented a broad cross section of the health care community including medical doctors, nurses, occupational therapists, physical therapists, pharmacists, disability advocates, paramedics, and people with lived experiences.

Based on initial feedback from event organizers, stakeholders, and students, the event was successful at facilitating professional, meaningful student-stakeholder interactions. Stakeholders described their conversations with students as professional and respectful with students coming prepared with questions and showing a willingness to learn and pivot their design approach. Students have expressed gratitude for the opportunity to participate in the event and an interest in seeing this event occur again in the future. The event organizers were able to observe how the preparatory workshop prepared students to make the most of the stakeholder interaction opportunity by coaching them on professionalism, setting goals, and preparing questions. While the event organizers acknowledge that this model did not lessen the challenging time commitment involved with organizing the event, they did see a clear benefit to connect students with stakeholders from the local community and supporting student lifelong learning. Future work includes a formal analysis of student and stakeholder perceptions of the event and developing a plan towards sustaining and growing the event and evidence-base.

Introduction

Incorporating people into the design process is one of the most challenging and rewarding aspects of engineering design. Navigating different perspectives, contexts, worldviews and

values as part of the design process has been shown to increase productivity, improve quality, improve acceptance, lower the ultimate cost of development, and lessen errors [1], [2], [3], [4]. Design is a core engineering activity [5], [6] that is central to the definitions of professional engineering work [7], [8], and the evaluation and accrediting of engineering programs [9], [10], [11]. Engineering design can be defined as a "systematic, intelligent process in which designers generate, evaluate, and specify concepts for devices, systems, or processes whose form and function achieve clients' objectives or users' needs while satisfying a specified set of constraints" [12]. There are many different methodologies for engaging in the process of engineering design. Some of these design processes are more technology-centered where others are more human-centered [13]. Within human-centered design processes, specific design processes and methodologies include humanitarian engineering [14], [15], humanity-centered design [16], user-centered design [17], [18], value sensitive design [2], empathetic design [19], [20], and participatory and co-design [21], [22]. One commonality of these more human-centered design processes is their identification and inclusion of users and stakeholders as being key to the design process [2], [3], [4], [12], [23] across a wide range of engineering disciplines [24], [25], [26], particularly in biomedical engineering [23], [26], [27], [28], [29]. A multi-stakeholder co-design process has been recommended for biomedical engineering to ensure that design solutions meet the needs of the diverse stakeholders in healthcare systems [26].

Including people in the design process can take many different forms and be called many different things. Collaborators, partners, participant, and people with lived experience are all terms that can be used somewhat interchangeably within this space. In the context of engineering design, the most common word is stakeholders, which are defined as "actors that can affect or be affected by the new product/service/product-service system" [24]. Stakeholders include direct stakeholders, who directly interact with the system, and indirect stakeholders, who could impact system development or will be indirectly impacted by the system [2]. The term stakeholder is used throughout this paper as it is commonly used in the engineering design lexicon and other related fields. It is important to note that the term stakeholder is not appropriate to use when working with Indigenous partners, as it does not acknowledge the important role Indigenous Peoples have as rights and title holders. As has been discussed in our earlier work [30] and Darling et al. 2023 [31], "it is important to acknowledge that this term is one with complex, context-specific meanings, particularly when engaging with Indigenous communities and Peoples". Stakeholder also places emphasis on people related concerns which may underemphasize important sustainability considerations related to the environment and the plants and animals residing within that environment [16]. Within this paper, the term stakeholder is used deliberately within the engineering context and currently broadly used lexicon while acknowledging the need for broader discipline examination and consideration of this lexicon and whether the lexicon needs updating, but as the project grows more work will be done with Indigenous colleagues to find inclusive framing and phrasing.

Engineering education increasingly includes teaching human-centered design processes as part of the fundamental skills necessary for design thinking with a key research and learning area being how to understand and engage with the people ultimately impacted by the design [32], [33]. It is

important to note that while there is a significant body of literature on the value of human-centered design, as well as foundations of how to teach it, there is not a significant body of knowledge on the challenges and practicalities of supporting students with experiential learning opportunities.

This is particularly true for engaging with stakeholders. There is consensus that stakeholder engagement is key to successful design yet providing meaningful student-stakeholder interaction opportunities is challenging due to academic, time, financial, and other constraints [34], and only a few case studies report on these activities [6], [20], [34], [35], [36], [37], [38]. Best practices for facilitating student-stakeholder interactions are lacking [38], particularly in biomedical engineering where case studies are minimal and our work in this area is one of only a few published [39]. Identified student challenges with stakeholder interactions include developing goals for stakeholder interactions, interacting successfully with stakeholders, and integrating diverse stakeholder needs into their design process [38].

Purpose

This paper presents a foundation for an evidence-based student-stakeholder interaction model that enables students to build needed skills and include stakeholders successfully in their design process by (1) presenting a multi-step student-stakeholder interaction model that addresses identified challenges and (2) provides a preliminary assessment of the interaction model based on event organizer, stakeholder, and student perceptions.

Approach

This multi-step student-stakeholder interaction model had four key steps: (1) capstone team applications, (2) student-stakeholder matching, (3) preparatory workshop, and (4) the student-stakeholder interactions themselves, called the Biomedical Stakeholder Café. It is also important to note that identifying and recruiting stakeholders and advertising the event to students are also critical preparatory steps for successful implementation and execution of the model.

This first-of-its-kind student-stakeholder interaction event, called the Biomedical Stakeholder Café, ran in Fall 2023. The overall goal was to facilitate capstone engineering students connecting with diverse biomedical stakeholders. The student-stakeholder interactions were focused on needs assessment design work when designers are developing a deep understanding of the problem, including its broader context and root causes, and translating this understanding into engineering specifications. In this stage of the design process, stakeholders can provide important lived experience insight and expertise. While additional structured interactions were not offered for later stages of the design process, students were given the opportunity to organize additional interactions with stakeholders based on their project needs and stakeholder willingness and availability.

In order to support the needs assessment phase of the design process, the last step of the student-stakeholder interaction model, the interactions themselves, had to occur as soon as possible in the term. In Fall 2023, there were fourteen calendar weeks to the term with week one and fourteen being partial weeks of three and two days, respectively.

Recruitment of stakeholders occurred predominantly in the months leading up to the fall term with some on-going recruitment during the first four weeks of term. Initial recruitment was done using the event organizers' personal networks and departmental networks with the aim of recruiting a diversity of health care professionals and individuals with lived experiences with diagnosed conditions and patient experiences within the health care system. On-going recruitment was focused on targeted recruitment of individuals to meet unmet expertise after reviewing capstone team applications.

The event was advertised to capstone teams throughout the entire Faculty of Engineering through several communication channels during the first two weeks of term. Recruitment posters were created and displayed in key engineering buildings throughout campus in high-traffic areas like hallways and elevators. All capstone instructors were asked to announce the event orally and online. Instructors were provided with a slide and written announcement, and event organizers announced the event in-person to some classes based on instructor preferences. Finally, the event was announced through faculty and departmental communication channels using a pre-existing communication protocol.

Capstone team applications were due by the end of week 2. These capstone applications gave the event organizers key pieces of information related to the team's problem space, home department, team size, food allergies, etc. Importantly, all teams were required to identify stakeholders they would like to connect with (e.g., patient with a spinal cord injury, occupational therapist, pharmacist, etc.) and at least one question they would like to ask this stakeholder. This directly targeted one of the known challenges of student-stakeholder interactions which is developing a goal for the interaction [38].

Applications were screened by event organizers during the first half of week 3 and all teams were told whether their application was successful or not before the end of week 3. Application screening focused on completeness of the application, clarity of problem space description, relevance of identified stakeholder(s), and ability of recruited stakeholders to support the team. Some teams were given a 'soft' acceptance dependent on the successful recruitment of additional stakeholders during on-going recruitment.

A preparatory workshop occurred during week 4. This preparatory workshop was one hour long and focused on providing all students with information regarding interviewing best practices, including 'introducing yourself', question development, semi-structured interviews, key tasks during interviews, documentation best practices, and appropriate behaviour during interviews. Similar to the application process, this step was intended to address the known challenge of students struggling to interact successfully with stakeholders [38]. All students were required to

complete the preparatory workshop, or they could not participate in the student-stakeholder interaction event.

In week 5, the last step was the student-stakeholder interactions themselves, called the Biomedical Stakeholder Café. Based on the number of students, stakeholders, interactions, and the available space, the event ran across two days for a one-hour duration on each day. Student-stakeholder interactions were all one-on-one (i.e., one team-one stakeholder) and lasted for 15 or 25 minutes each. Capstone teams can have as many as five team members. However, at most, three team members participated in each student-stakeholder interaction.

Students who wished to continue interacting with any of the stakeholders reached out to the event organizers. The event organizers would then ask the stakeholders if they were willing to continue interacting with that team. Willing stakeholders were then directly connected to the student teams and the students were then in charge of organizing appropriate next steps to support their capstone design project.

A fuller description of the Biomedical Stakeholder Café model and implementation are presented in Howcroft et al. 2024 [40].

Methods

Given the novel nature of this student-stakeholder interaction model, it is important to evaluate the model to determine whether it achieved the overall goal of supporting capstone teams in their design work and whether it mitigated some of the literature identified challenges related to student-stakeholder interactions [38]. To this end, three different data sources were used to assess the model: (1) event organizer observations, (2) stakeholder focus groups, and (3) student surveys.

Event organizer observations serve as an initial, preliminary data point. The event organizers were involved with implementing all of the model steps from stakeholder recruitment to the Biomedical Stakeholder Café itself. These observations can provide insight into the quality of student applications, student and stakeholder engagement throughout the process, and the time and logistical demands associated with implementing the model. These last observations are critically important given that organizational demands are a known challenge of implementing student-stakeholder interactions [34].

Stakeholder focus groups occurred immediately after the Biomedical Stakeholder Café event where the student-stakeholder interactions occurred. A semi-structured format was used for the focus group with questions focusing on describing their overall experience, interactions with the students, and interactions with event organizers. They were also asked to identify elements of the event they liked, would change, and thoughts to improve the event. A brief demographics questionnaire was also completed.

Students were asked to complete two surveys: one immediately following the Biomedical Stakeholder Café and one at the end of their capstone projects. At the time of writing this paper, the capstone projects are still on-going, and this second survey has yet to be distributed. The first survey asked students to provide their opinion of the potential value of the preparatory workshop and Biomedical Stakeholder Café using both closed and open-ended questions, including a likelihood to recommend question. This paper will focus on event organizer observations and initial, preliminary analysis of findings from stakeholder and student input.

All stakeholders and students provided informed consent to participate in the focus groups and student surveys, respectively. Participation in these elements was not required to participate in the Biomedical Stakeholder Café. This study received ethics approval University of Waterloo Office of Research REB 45531.

Outcomes & Discussion

The student-stakeholder model, culminating in the Biomedical Stakeholder Café, successfully ran in Fall 2023 with 23 capstone teams across four programs at the University of Waterloo connecting with 18 diverse biomedical stakeholders.

The stakeholders represented a broad cross section of the health care community including medical doctors, nurses, occupational therapists, physical therapists, pharmacists, disability advocates, paramedics, and people with lived experiences. While most of these stakeholders were recruited in the preparatory phase, a disability advocate, paramedic, and physical therapist were recruited during on-going recruitment to meet the needs of specific capstone teams.

The application system had 62 unique engagements with 28 complete application forms. Of these 28 applicants, 25 teams were invited to and participated in the preparatory workshop, representing 107 students, and 23 teams had at least one student-stakeholder interaction. Stakeholders could not be recruited for two teams during on-going stakeholder recruitment which resulted in these two teams only participating in the preparatory workshop and not proceeding to the Biomedical Stakeholder Café. Across the two days of the Biomedical Stakeholder Café, 44 conversations occurred with each capstone team engaging in one to three stakeholder conversations.

Of the 18 stakeholders, 16 participated in the focus group sessions. Of the focus group participants, nine identified as female and seven identified as male. The average age was 44.1 ± 15.4 years. Thirty-five (32.7%) of the 107 students completed the first survey after participating in the Biomedical Stakeholder Café. Of the survey respondents, twenty-five identified as female, eight as male, and one respondent preferred not to identify their gender identity. The average age was 21.7 ± 0.6 years.

The preparatory workshop appears to have been successful at preparing students for the student-stakeholder interactions. Event organizers observed that students were engaged throughout the session and participated in active learning opportunities intended to challenge their assumptions and biases about stakeholders and practice interviewing by asking each other potentially challenging questions. Most students also saw value in this event as a learning opportunity and important to remain as a required preparation for the student-stakeholder interactions in the Biomedical Stakeholder Café (Figure 1). They also offered insight into how this workshop helped mitigate the challenge of knowing how to interact successfully with stakeholders:

> *"It (the preparatory workshop) helped prepare us with tools for guiding the conversation and navigating complex and difficult topics during interviews. Without this workshop to inform our preparation, the interviews would have been more awkward and much less successful."*

> *"Reminder of common mistakes students make when interviewing stakeholders – was useful to know so that we could avoid making the same mistakes."*

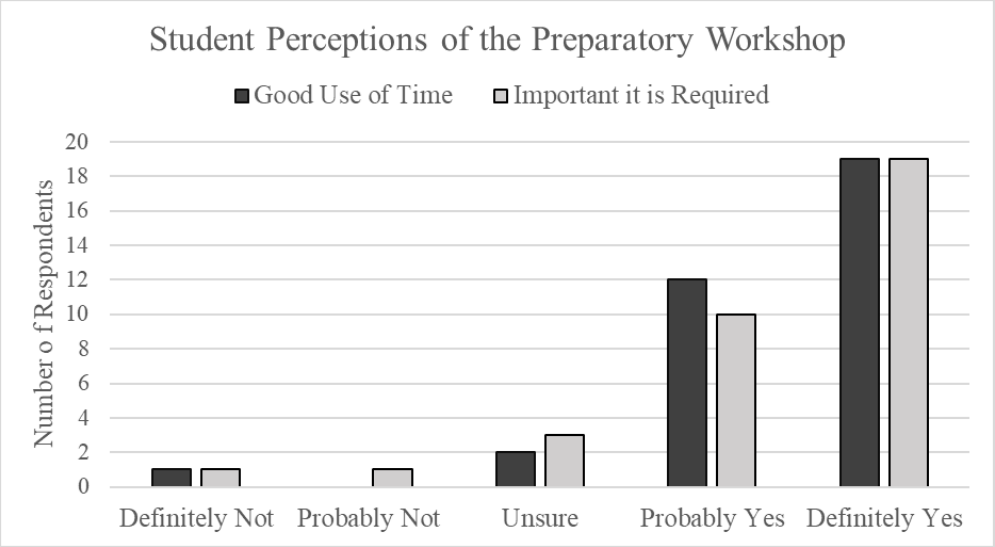

Figure 1. Student perceptions of the preparatory workshop.

The Biomedical Stakeholder Café itself was also successful at achieving the desired goal of facilitating student-stakeholder interactions. Event organizers observed lively and dynamic conversations throughout the entirety of the two sessions. Students were in charge of keeping track of time, wrapping up conversations, and heading to their next conversation throughout the one-hour session. All students were able to navigate these transitions successfully without support or reminders from event organizers. From the student perspective, most students would recommend this event to a friend or classmate with 78% of survey respondents (n = 25) being promotors, 19% (n = 6) being passive, and one detractor. Most student (85.7%) felt that they learned something at the Biomedical Stakeholder Café. Open-ended responses suggest that this was related to the intended goal of supporting the needs assessment phase of the design process:

"I liked that we were paired with stakeholders who had relevant professional and lived experience with our group's problem space. Their thoughts and opinions were extremely insightful and helped inform our understanding of our user group and their needs."

"We asked stakeholders to identify some of the challenges that our users faced, and identify the pros and cons of existing solutions to better understand the need that we should address. This helped us establish benchmarks for our project's performance and prioritize different requirements."

Some of these student-identified benefits were in contrast to a known challenge of integrating insight from diverse stakeholders into design [38]:

"I liked that we were able to speak to individuals with different experiences and perspectives."

The stakeholders themselves also shared positive opinions of their experience participating in the Biomedical Stakeholder Café. They described their conversations with students as professional and respectful. They also identified that students showed a clear willingness to actively listen, learn, and pivot their design approach based on offered insight.

"As a therapist, it's at first it was like, what am I gonna [talk to] students [about]? But it was actually really meaningful and refreshing for me to come in and talk with people that I don't usually talk with, and just see how some of these projects would really enrich the lives of the clients."

"I was surprised at how sharp they were about picking up on things that they hadn't necessarily thought we would be talking about. I felt there was a very admirable segue into, well, this is what we wanted to talk about, to have you considered the psychological dimensions of patients and how people will access and use whatever it is…"

The students and stakeholders did provide some important areas for future improvement. Fifteen- and 25-minute student-stakeholder conversations were scheduled. Students and stakeholders indicated a preference for the longer 25-minute conversations, indicating that 15 minutes was insufficient. There was also a desire for an overall longer event with more stakeholder interaction opportunities, conversations longer than 25 minutes, more stakeholders including some with technical expertise, and the opportunity for a less structured mingling time at the start and end of the event.

In addition to these student and stakeholder recommendations for future improvements, event organizers indicated that this student-stakeholder interaction model did not lessen the time commitment involved with organizing, facilitating, and hosting the key steps of the model. Implementing the model did involve a substantial time commitment, particularly in recruiting and communicating with stakeholders, matching student teams with appropriate stakeholders, and communicating with student teams.

Future Work

The assessment of the student-stakeholder interaction model is still on-going. The student survey and stakeholder focus group data presented here represents a preliminary analysis. A more thorough and formal analysis is planned as an immediate next step. Additionally, the capstone design teams who participated in the Biomedical Stakeholder Café are still working on their capstone projects with the second student survey planned to run at the completion of these projects in April 2024. These surveys will provide important information about the longer-term value of the facilitated student-stakeholder interactions at the café event and insight regarding student-driven on-going interactions with stakeholders.

Sustaining this student-stakeholder interaction model is another important area of future work. The event organizers are currently exploring opportunities for sustained funding from potential institutional and donor sources. Sustaining this event will allow for an exploration of longer duration conversations and investigating the potential value of received recommendations like less formal ‘mingling’ sessions at the start and end of the more structured, scheduled conversations during the Café.

It is also important to acknowledge that the implemented student-stakeholder interaction model focused on a specific subset of stakeholders and design projects – those with biomedical relevance. It will be important to expand and explore this model with different areas of foci and stakeholders.

The value of this student-stakeholder interaction model could be more fully understood by having a deeper understanding of the students who choose to participate and those who chose not to participate. It is not clear from the available data whether participating students were more likely to be ‘local’ or ‘non-local’ to the region or whether they had already made connections with stakeholders independently through their own networks or engagement work. This insight into distinguishing characteristics of participating and non-participating capstone teams could give interesting insight into the types of students that this model best supports and those that it does not support.

Conclusion

Based on initial feedback from event organizers, stakeholders, and students, the event was successful at facilitating professional, meaningful student-stakeholder interactions. Stakeholders

described their conversations with students as professional and respectful with students coming prepared with questions and showing a willingness to learn and pivot their design approach. Students have expressed gratitude for the opportunity to participate in the event and an interest in seeing this event occur again in the future. The event organizers were able to observe how the preparatory workshop prepared students to make the most of the stakeholder interaction opportunity by coaching them on professionalism, setting goals, and preparing questions. While the event organizers acknowledge that this model did not lessen the challenging time commitment involved with organizing the event, they did see a clear benefit to connect students with stakeholders from the local community and supporting student lifelong learning. Future work includes a formal analysis of student and stakeholder perceptions of the event and developing a plan towards sustaining and growing the event and evidence-base will be provided.

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