WIP: Curricular adoption of a clinical immersion program

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Abstract

Over the past 15 years, clinical immersion experiences in biomedical engineering (BME) have become more prevalent in curricula. At the University of Illinois Chicago (UIC), our Clinical Immersion Program (CIP) has expanded over 12 years with several curricular revisions. Now, the program emphasizes identification and validation of projects for longitudinal development via a distributed and interdisciplinary pipeline. Validation of unmet clinical needs is performed using a Design Thinking framework developed by IDEO, which assesses a need/project according to three core criteria: *desirability* (substantiating the needs), *feasibility* (ability for a team to enact a solution), and *viability* (marketspace for a solution). However, due to the logistics associated with placing students in clinical environments, our CIP has always remained a selective experience. To scale the impact of CIP, here we describe the revision of a senior-level course entitled "Medical Technology Assessment" to incorporate key didactic materials and learning outcomes developed for CIP. In this revised course, student teams are not immersed in the clinical environment but instead navigate the Design Thinking framework as it applies to an assigned medical device innovation. At the end of the class, students prepare a final report to substantiate the innovation according to the IDEO framework. This work-in-progress reports on the programmatic scheduling, activities, assignments, and learning objectives of this course. While not a substitute for a firsthand immersion experience, this course offers a framework for assessment of medical device innovation based on core content from our CIP.

Introduction

Over the past 15 years, dozens of clinical immersion experiences in biomedical engineering (BME) have been described [1]. These experiences were broadly designed to augment educational outcomes and workforce training through exposure to the clinical environment. Recent literature regarding clinical immersion experiences, or similar initiatives, have described virtual adaptations [2], incorporation of virtual reality[3], evaluation of quantitative and qualitative outcomes [4], critical participant self-reflection [5], faculty reflections [6], "voice of customer" videos for empathy in design [7], community- or urban-based immersion [8, 9], and the design of permanent courses [10, 11]. At the University of Illinois Chicago (UIC), our Clinical Immersion Program (CIP) has expanded over 12 years with several curricular revisions. Originally, our CIP was comprised of two rotations for BME students [12]. Later, CIP expanded to include medical students from the Innovation Medicine program (IMED) with BME students on interdisciplinary teams [13-15]. Now, the program emphasizes identification and validation of projects for longitudinal development via a distributed and interdisciplinary pipeline [16-18]. Validation of unmet clinical needs is performed using a Design Thinking framework developed by IDEO, which assesses an unmet need/project according to three core criteria: *desirability* (substantiating the needs), *feasibility* (ability for a team to enact a solution), and *viability* (marketspace for a solution) [19]. This framework was selected because of program faculty use and alignment with UIC's technology transfer process. Validated needs/projects are then introduced into a longitudinal project pipeline for student-driven innovation. However, due to the logistics associated with placing students in clinical environments, our CIP has always remained a selective experience for no more than twelve BME students each summer. To scale the impact of CIP, here we describe the revision of an elective, senior-level course to incorporate key didactic materials and learning outcomes developed for CIP. This work-in-progress reports

on the programmatic scheduling, activities, assignments, and learning objectives of this course. With this course development, we intend to align classroom theory, research practice, and commercialization to ultimately enhance the innovation potential of students.

Methods

Integration of Clinical Immersion Program Content

At UIC, we have long offered BME 402, entitled "Medical Technology Assessment." This course was taught using a discussion-based, case review model. However, the course had little prescribed lecture content to standardize the process of technology assessment. Therefore, we integrated CIP didactic content into BME 402 as part of a course revision to bring CIP subject matter to a broader BME student population. Given the structure of the course and enrollment, students are not immersed in the clinical environment but instead learn the IDEO Design Thinking framework as it applies to medical device design and innovation through case studies. Specifically, we introduced CIP content related to the evaluation of user *desirability* (e.g., needs statements), technical *feasibility* and market *viability* for medical devices, including secondary research basics (e.g., literature assessment, intellectual property assessment) and market analysis (competitive landscape assessment, medical reimbursements, and business plan).

Course Structure

BME 402 was offered as 2 credit hours, meeting once a week for the 15-week semester. Twenty four (24) students enrolled in the course during Spring 2025: 10 undergraduate BME students, 3 graduate BME students, and 11 medical students from the Innovation Medicine co-curricular program. At the start of the semester, 8 mixed student teams were formed, and each was assigned a medical device from a startup company to evaluate as a case study. Companies and products included Neopenda (neonatal vitals monitoring), Edge Surgical (orthopedic surgical instrumentation), Briteseed (laparoscopic imaging instrumentation), Novascan (cancer detection), Rhaeos (monitoring for hydrocephalus treatment), Ad Astra Diagnostics (rapid complete blood cell count measurement), Theta Neurotech (wearable electroencephalogram isntrumentation), and Ciconia Medical (ultrasound measurement of cervix dilation). Each startup was contacted for participation in the course and most agreed to serve as a contact for consultation throughout the semester. In class, teams applied concepts from the CIP content to their assigned medical technology. At the end of the semester, teams prepared a final report to summarize the innovation of their assigned device according to the IDEO framework. The Table shows a weekly schedule of BME 402 with the CIP content denoted by asterisk. Notably, content from the CIP comprised virtually all the lecture material in this revised course. Formal learning objectives included: 1) synthesize themes using design thinking techniques, 2) iteratively develop needs statements, 3) identify competing solutions and critically analyze the competitive landscape, 4) investigate and critique intellectual property landscape, 5) develop a business model canvas, and 6) synthesize and substantiate real medical technology startup proposals.

Grades were largely provided based on four major deliverables: a midterm poster presentation (20%), a final poster presentation (20%), a midterm paper draft (20%), and a final paper (20%). Given the course involved substantial team-based work, attendance and peer evaluations were also included in grades (10% each). Midterm deliverables assessed needs statements (*desirability),* as well as a competitive landscape for solutions (*desirability, feasibility*). Final

deliverables assessed need statements (*desirability*), competitive landscape (*desirability, feasibility*), intellectual property (*feasibility*), and marketability (*viability*).

Table. Schedule of *Medical Technology Assessment* Course revised to include CIP content with corresponding topics. Asterisk indicates content from CIP.

Week	Content	Topics
1	Introduction, syllabus, introductory activity/exercise	
2	Biodesign disease state fundamentals	Clinical needs, disease state analysis,
3	Guest lecture	Needs finding personal experience and academic efforts, writing and scoping needs statements
4	Needs Statements writing and secondary research *	Leveraging literature in needs statements, peer review, types of research articles, literature search engines
5	Working session	
6	Competitive landscape assessment*	Commercial solutions, competitor analysis, analogs between industries, FDA FAERS and MAUDE
7	Midterm poster presentation	
8	Intellectual property (IP) assessment*	Types of IP, criteria for patents, searching for IP, understanding claims
9	Working session	
10	Guest lecture	Navigating law around IP, patent process
11	Guest lecture and case study	Bringing an electroretinogram device to the market
12	Market analysis*	Market analytics, market analytics search engines, total addressable market
13	Medical reimbursement*	Supply chain channels and sourcing, group purchasing organizations, reimbursements and medical coding
14	Business plan*	Business models
15	Final presentations	

Initial Results and Discussion

The revision of our BME 402 course to include CIP content represents an important effort to scale the impact presented by clinical immersion experiences. Upon reflection, the course structure was flexible, and the working sessions were critical to facilitate translation of course content and its application. The final reports were evaluated by the authors (MK, MGB) and were judged to adequately reason and substantiate device *feasibility* and *viability* according to the CIP content. From the course evaluations completed by BME students (7/13), students rated course quality at an average of 4.25/5, suggesting a positive experience with the new course. One student commented that “collaborating with medical students was [a] very informative…experience.” There were limitations in this course revision. First, this course is graded on a traditional A-F scale for BME students but as a pass-fail elective for the medical students. This resulted in variable "buy-in" by each group of students and occasional challenges related to team dynamics and workload distribution. In fact, multiple BME students from the

course evaluations noted feeling that medical students were not similarly invested in the course deliverables and outcomes. Second, while the hybrid (primarily virtual) course structure was chosen to provide flexibility in interdisciplinary teaming, it also inadvertently siloed student groups (i.e., engineering versus medicine). Third, the companies were rarely contacted by student teams, leaving their expertise and experiences regarding their own product portfolios unjustifiably underutilized. In future versions, we would modify the course to use an in-person format to enhance teaming, and make engagement with the companies part of the grading criteria. Additionally, inviting company representatives to final presentations could enhance student reflection on findings.

While the curricular adoption of our CIP content doesn't permit immersion experiences with primary identification of clinical problems, it does provide a valuable opportunity to evaluate, refine, and understand medical device innovation. Moreover, enrolling students from multiple programs (i.e., undergraduate, graduate, medicine) enables interdisciplinary teaming, which is known to enhance learning experiences. The curricular adoption of our CIP content is a valuable way to scale the impact from our program to a broader student body.

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