

Board 13: Work in Progress: Clinical Immersion Model for Biomedical Engineering Undergraduate Students with Experienced Nurses

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Abstract: There are many factors that can affect biomedical engineers readiness and ability to identify healthcare providers clinical needs. Some of these factors include age, maturity, and previous experience with healthcare providers. Other factors include healthcare providers own communication style and the type of information they are providing. Clinical experiences among biomedical engineering (BME) students have increasingly been incorporated in undergraduate biomedical engineering curricula. This pilot study presents and assesses a clinical immersion framework for biomedical engineering undergraduate students with experienced nurses. We launched a summer clinical immersion program utilizing a “Student Experience Educational” Program offered by a not-for-profit healthcare organization.

I. Introduction:

The goals of this pilot study are to present a new clinical immersion framework for biomedical engineering students and to assess the effects of this framework on the certainty of participating students in their career aspirations, technology-driven problem-solving skills, engineering design self-efficacy, empathy, and communication. The immersion framework utilized an existing healthcare “Observation Program” offered by a not-for-profit healthcare organization with 1032 beds, over 1000 active providers, and a team of more than 7000 employees. We will highlight the program structure, our novel assessment tools, and initial outcomes, as well as propose future directions for the framework to ensure sustainability and success.

At most universities, clinical immersion programs for the biomedical engineering students are offered as extracurricular and usually occur during the summer [1-9]. Some institutions adopted semester-based immersion models [12], some adopted clinical field trips and visits within a course [11], and finally, some adopted visits to clinical simulation laboratories [10]. In summer based clinical immersion programs, students must apply and compete against their peers to be selected. This is a limiting factor especially for large and fast-growing programs. Summer immersion programs are usually short in their duration (2 weeks up to 10 weeks) [1-9], therefore, provide limited exposure to clinical setting and personal. Offering semester-based clinical immersion programs poses another set of challenges. Universities must establish hospital affiliation agreements and recruit clinical participants to supervise students. The number of clinical participants needed to supervise students increases as the number of students increases. Field trips and visits within a course also require maintaining a long-term clinical involvement and provide limited clinical exposure. Visits to clinical simulation laboratories can be a valuable experience for the students, however, it lacks the exposure to the dynamics of a real-world clinical setup and challenges. Establishing and maintaining a successful clinical immersion program can be especially challenging for new biomedical engineering programs in small academic institutions and for programs in rural areas or in areas with a shortages of healthcare professionals. A clinical immersion framework around a well-established Healthcare Providers Clinical Experience Educational Programs may help addressing all these challenges. We hypothesis that biomedical engineering students who participate in a clinical immersion framework that utilizes a well-established healthcare observation program offered by a healthcare organization will have increased confidence in their career aspirations, technology-driven problem-solving skills, engineering design self-efficacy, empathy for observed challenges in healthcare institutions, and in their effective communication with healthcare providers and clinical engineers.

II. Methods:

A. Participants: Three biomedical engineering students were recruited for the immersion program via an open call for enrollment. The biomedical engineering students were chosen based on submitted one-page statement describing their education and career goals, resumes that summarizes extracurricular activities, laboratory/research experiences, and work history, and finally based on letters of recommendation submitted on behalf of interested students. No specific student populations are either targeted and/or excluded. The three biomedical engineering students who participated in the program were the only students who applied. The small number of participants reflects the fact that our biomedical engineering program is only 4 years old with a small student population.

B. The Clinical Immersion Framework: A well-established healthcare “Student Experience Educational” Program offered by a leading local healthcare organization was utilized in the clinical immersion framework used in this study [14]. The “Student Experience Educational” Program offers internships and healthcare observation opportunities for high school and college students to provide the guidance, tools and suitable instruction that will assist them further their career goals. The clinical immersion framework of this study utilized the observation opportunities offered through this program [15]. No direct, hands-on learning was offered. Each participating biomedical engineering (BME) students observed nurses for about 68 hours in their patient care duties in four different clinical departments/units: Progressive Care Unit (PCU), Emergency Department (ED), Intensive Care Unit (ICU), and in the Interventional Radiology and Stress Lab (IR/Stress). Individually, each BME student spent 3 workdays in CPU, 3 workdays in ED, 3 workdays inn ICU, and one day in the IR/Stress lab. Students shadowed one experienced nurse every day. Students recorded the challenges and the un-met needs the nurses faced while performing their daily care duties and the ones mentioned from previous experiences. The rotational schedule was developed by the research team after consulting with the clinical staff in the healthcare organization. Prior to the clinical immersion experience, students completed 5 online training modules available for free to the students through the university library “Infobase Learning Cloud” subscription [16]. The modules covered content related to HIPPA & Compliance, Professionalism in the workplace, effective note-taking tips, critical thinking, and research essentials. The students also reviewed required documentation provided by the host healthcare organization, completed an observation application for the healthcare organization, and provided TB, Flu, and Covid 19 Vaccination documentation prior to their clinical immersion experience.

C. Data Collection & Analysis: Two surveying models were used to collect biomedical engineering students feedback pre- and post-clinical immersion to assess the effects of the used clinical immersion framework on students career aspirations, design-self-efficacy, and behavior. In the first surveying model, participants had five options for each answer to mark the most appropriate answer: ‘certain’, ‘somehow certain’, ‘neutral’, ‘somehow not certain’, and ‘not certain’. Three different questionnaires were prepared by the research group: a Career Aspiration questionnaire (Appendix I), an Engineering Design Self-efficacy questionnaire (Appendix II), and a Trends & Behavior questionnaire (Appendix III). In the second surveying model, the generic scale from 0% up to 100%, developed by Carberry et al. [13], was adopted and used to assess participants engineering design skills prior and post the clinical immersion experience. The spread and skewness of choices were used to indicate students ability to perform the tasks of

the engineering design process. The numbers of selected questionnaires options were compared pre- and post-immersion. All questionnaires were filled in the educational institution of the students. All questionnaires were approved by the educational institution Institutional Review Board (IRB). The small sample size in this pilot study made it difficult to perform detailed statistical analysis.

III. Results:

A. Career Aspiration: Post-clinical immersion feedback from this pilot study showed changes in students career aspirations. The data indicated increased aspiration to obtain an advanced degree (Masters and/or PhD), to engage in design and development activities with healthcare providers, and to engage in research activities with healthcare providers (Appendix IV). No changes in students certainty in becoming an engineer or a physician were detected.

B. Engineering Design Self-Efficacy: Post-clinical immersion feedback from students suggests increased confidence in their engineering design abilities and efficacy. The post-immersion data shows a shift in the knowledge about the various challenges and needs in healthcare institutions, suggesting that students are more clinically informed. The data also suggest increased confidence in students structured technology-driven problem-solving skills (Appendix V). The assessment of the students ability to perform the different tasks associated with the engineering design process before and after the clinical immersion experience suggests an increase in students self confidence in performing such tasks (Appendix VI).

C. Trends & Behavior: After clinical immersion, students feedback suggests shifts in their trends and behavior toward clinical engineers as well as toward nurses. The data shows increased certainty in the students ability to empathize with observed challenges in healthcare institutions and in the effectiveness of their communication skills with clinical engineers and nurses (Appendix VI).

IV. Discussion & Conclusion:

This pilot study was designed to assess the effects of the clinical immersion framework outlined above on biomedical engineering students confidence (certainty) in their career aspirations, technology-driven problem-solving skills engineering design self-efficacy, empathy, and communication skills. The study used two surveying models to collect biomedical engineering students feedback pre- and post-immersion. The obtained feedback from this pilot study suggests that the implemented clinical immersion framework increased students certainty about their career aspirations into becoming engineers who seek to engage in design and development activities, and who are also certain about their structured technology-driven problem-solving skills. Participated students also reported increased confidence-in their abilities to empathize with observed clinical needs and challenges, identifying unmet clinical needs, and in effectively communicating with nurses and clinical engineers. It is worth noting that nurses are the end users of many medical equipment and solutions, and their expertise and knowledge are valuable to engineers when trying to identify unmet medical needs and challenges. That is why nurses were the targeted healthcare professional group in this study. Future work includes increasing the number of biomedical engineering students, further developing and refining the clinical immersion framework to include other healthcare providers and first-year biomedical engineering students, assessing the identified unmet needs collected during the clinical immersion experience, and developing marketable products to address those needs. We will also collect data on students satisfaction with the used clinical immersion model.

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Appendix I: Career Aspiration Questionnaire

Survey/Questionnaire No.:

Date:

Time:

Tell us about your career aspirations. Rate your degree of certainty to commit to each of the following career pathways by selecting one of the 5 choices below each question. These 5 multiple-choice questions survey will take around 5 minutes to complete. Your answers are anonymous and will be used to analyze the correlation between the clinical immersion experience and participants career certainty. We truly appreciate your insight and your time.

1) My career aspiration is to become an engineer.

certain	somehow certain	neutral	somehow not certain	not certain
☐	☐	☐	☐	☐

2) My career aspiration is to become a physician.

certain	somehow certain	neutral	somehow not certain	not certain
☐	☐	☐	☐	☐

3) My career aspiration is to obtain an advanced degree: Masters and/or PhD.

certain	somehow certain	neutral	somehow not certain	not certain
☐	☐	☐	☐	☐

4) My career aspiration is to engage in design and development activities with healthcare providers.

certain	somehow certain	neutral	somehow not certain	not certain
☐	☐	☐	☐	☐

5) My career aspiration is to engage in research activities with healthcare providers.

certain	somehow certain	neutral	somehow not certain	not certain
☐	☐	☐	☐	☐

Appendix II: Engineering Design Self-Efficacy Questionnaire

Survey/Questionnaire No.:

Date:

Time:

Tell us about your problem-solving skills and abilities in engineering design and development. In part 1, Rate your degree of certainty by selecting one of the 5 choices below each question. In part 2, rate your degree of “fill in task-specific self-concept of interest” to perform the following tasks by recording a number from 0 to 100. (0 = low; 50 = moderate; 100 = high). These questions survey will take around 10 minutes to complete. Your answers are anonymous and will be used to analyze the correlation between the clinical immersion experience and participants problem solving skills and abilities in Engineering Design Self-Efficacy. We truly appreciate your insight and your time.

Appendix II - Part 1:

1) You are informed about the various challenges and needs in healthcare institutions.

certain somehow certain neutral somehow not certain not certain

○ ○ ○ ○ ○

2) You have solid general problem-solving skills.

certain somehow certain neutral somehow not certain not certain

○ ○ ○ ○ ○

3) You have solid technology-driven problem-solving skills.

certain somehow certain neutral somehow not certain not certain

○ ○ ○ ○ ○

Appendix II - Part 2:

Rate your degree of “fill in task-specific self-concept of interest” to perform the following tasks by recording a number from 0 to 100. (0 = low; 50 = moderate; 100 = high)

[illegible]

Appendix III: Trends in Behavior Questionnaire

Survey/Questionnaire No.:

Date:

Time:

Tell us about your trends in behavior and thoughts. Rate your degree of certainty of your empathy and abilities to communicate with engineers and nurses by selecting one of the 5 choices below each question. These questions survey will take around 5 minutes to complete. Your answers are anonymous and will be used to analyze the correlation between the clinical immersion experience and participants trends in behavior and knowledge. We truly appreciate your insight and your time.

1) You empathize with observed challenges in healthcare institutions.

certain	somehow certain	neutral	somehow not certain	not certain
☐	☐	☐	☐	☐

2) You communicate effectively with clinical engineers.

certain	somehow certain	neutral	somehow not certain	not certain
☐	☐	☐	☐	☐

3) You communicate effectively with nurses.

certain	somehow certain	neutral	somehow not certain	not certain
☐	☐	☐	☐	☐

Appendix IV: Career Aspirations Feedback Results

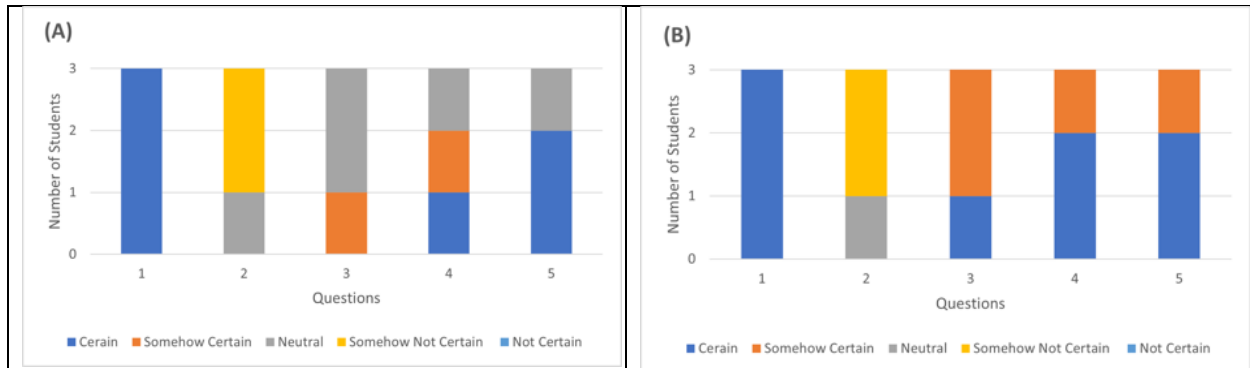


Figure 1: The clinical immersion of biomedical engineering students with experienced nurses spurred an increased aspiration to attain a Masters and/or PhD degree (Q1), to engage in design and development activities with healthcare providers (Q2), and to engage in research activities with healthcare providers (Q3). Students were certain of becoming an engineer before and after the clinical immersion experience (Q1) and stayed neutral and somehow not certain about pursuing a medical degree (Q2). (A) Students Pre-immersion choices. (B) Students' Post-immersion choices.

Appendix V: Engineering Design Abilities and Efficacy Feedback Results

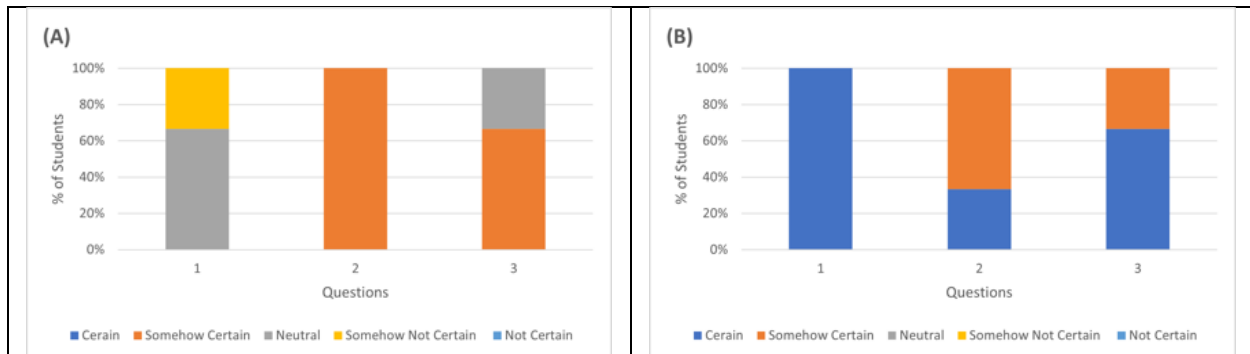


Figure 2: The clinical immersion of biomedical engineering students with experienced nurses spurred an increased confidence in students' knowledge about the various challenges and needs in healthcare institutions (Q1), their general problem-solving skills (Q2), and in their technology-driven problem-solving skills (Q3). (A) Students Pre-immersion choices. (B) Students' Post-immersion choices.

Appendix VI: Participants Engineering Design Skills Feedback Results

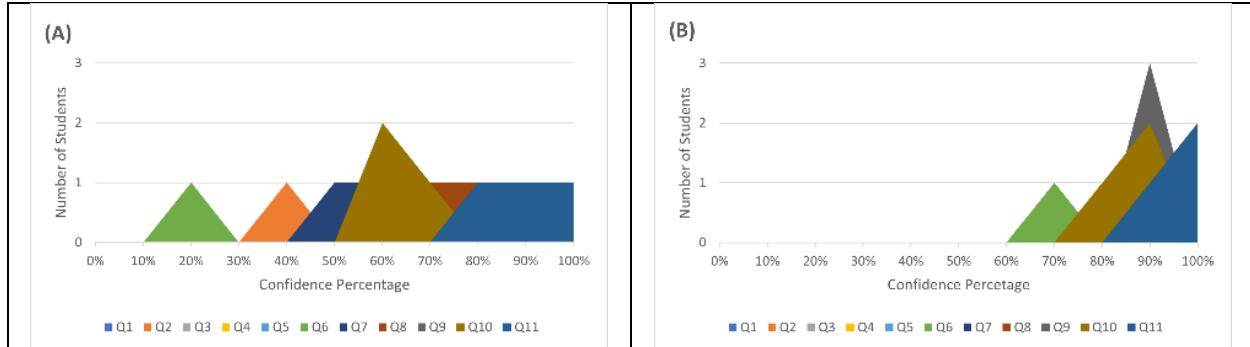


Figure 3: Negative Skewness and narrowing of the %confidence range were observed in students' choices post immersion suggesting that the clinical immersion of biomedical engineering students with experienced nurses spurred an increased confidence in students Engineering Design Self-Efficacy. (A) Students Pre-immersion choices. (B) Students' Post-immersion choices.

Appendix VII: Trends and Behavior Feedback Results

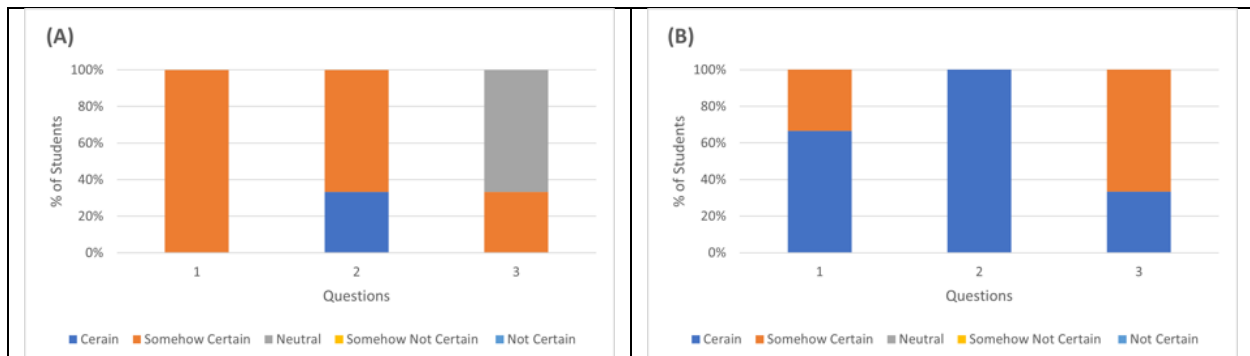


Figure 4: The clinical immersion of biomedical engineering students with experienced nurses affected students' trends and behavior. The immersion experience spurred an increased confidence in students' ability to empathize with observed challenges in healthcare institutions (Q1), their communication effectiveness with clinical engineers (Q2), and with nurses (Q3). (A) Students Pre-immersion choices. (B) Students' Post-immersion choices.