Work in Progress: A Clinical Immersion Program for Broad Curricular Impact

Dr. William H Guilford, University of Virginia

Will Guilford is an Associate Professor of Biomedical Engineering at the University of Virginia. He is also the Assistant Dean for Undergraduate Education in the School of Engineering. He received his B.S. in Biology and Chemistry from St. Francis College in Ft. Wayne, Indiana and his Ph.D. in Physiology from the University of Arizona. Will did his postdoctoral training in Molecular Biophysics at the University of Vermont. His research interests include novel assessments of educational efficacy, the molecular basis of cell movement, and the mitigation of infectious diseases.

Meg Keeley M.D.
Dr. Brian P. Helmke, University of Virginia

Brian Helmke is currently Associate Professor of Biomedical Engineering at the University of Virginia. He received the B.S.E. in bioengineering from the University of Pennsylvania, the B.S.Econ. from The Wharton School of the University of Pennsylvania, and the Ph.D. in bioengineering from the University of California, San Diego. Brian's research interests include cardiovascular physiology, cellular mechanobiology, and nanotechnology-based biomaterials. He is also interested in technology-enhanced teaching and in experiential learning for undergraduates in science and engineering.

Dr. Timothy E. Allen, University of Virginia

Dr. Timothy E. Allen is an Associate Professor in the Department of Biomedical Engineering at the University of Virginia. He received a B.S.E. in Biomedical Engineering at Duke University and M.S. and Ph.D. degrees in Bioengineering at the University of California, San Diego. Dr. Allen's teaching activities include coordinating the core undergraduate teaching labs and the Capstone Design sequence in the BME department at the University of Virginia, and his research interests are in the fields of computational biology and bioinformatics. He is also interested in evaluating the pedagogical approaches optimal for teaching lab concepts and skills, computational modeling approaches, and professionalism within design classes. Dr. Allen also serves as PI and director for an NSF-funded Multi-Scale Systems Bioengineering REU site at U.Va.

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Problem identification remains a significant challenge in the education of biomedical engineers since access to clinics and clinicians is limited. A popular approach to overcoming this limitation is the clinical immersion experience [1]–[6], which fall under the umbrella of "high-impact educational practices" – activities that have especially significant effects on learning, skills accumulation, and personal advancement [7].

We launched a summer clinical immersion program with broad curricular impact for Biomedical Engineering (BME). Our program at the University of Virginia pairs undergraduate "BME Clinical Scholars" with third year medical students to act as observers during ten-weeks of the medical students' summer clinical clerkships. The Clinical Scholars gain a vantage on the problems encountered daily by clinicians through extended immersion in a subset of clinical fields for several weeks each. Two sets of written deliverables are expected of every Clinical Scholar from each clinical clerkship in which they are immersed. Each of these deliverables is designed to extend the impact of the clinical experience to a much larger number of students. We here report on the inaugural year of our Clinical Scholars program, its impact on participants, and lessons learned on how to broaden its impact to non-participating students via our BME curriculum.

Scholar selection

Applicants to the clinical immersion program must be either rising 3rd or rising 4th year biomedical engineering students. As a result, by the time they enter the clinical environment all participants will have completed one semester of quantitative human physiology, and a course in cell and molecular biology for engineers. A holistic yet targeted admissions process helps to ensure the diversity of the Clinical Scholar cohorts. Finalists are selected based on their response to several reflective questions rather than on quantitative metrics (e.g. "Reflect on your life story...", "Do you consider yourself an observant person?...", "What do you hope to achieve through this program?"). Ten finalists are invited for brief interviews, and five Scholars are chosen based on those interviews, letters of recommendation, and the reflective essays.

Scholar preparation

The Clinical Scholars are required to obtain appropriate inoculations, to be fitted for a respiratory mask, and to complete four training elements before entering the clinical environment.

1. Responsible Conduct of Research (RCR) training.
2. HIPAA training, and other training as required by the University Health System.
3. Elements of the "Transition Course," which is designed to prepare medical students to enter their year of clinical clerkship rotations.
4. Observation, record keeping, and professional conduct training.

The learning community

Our program embeds Clinical Scholars directly within established learning communities of third-year medical students. Third-year medical students have the knowledge and experience to help the BME students understand the logistics and expectations of the clinical environment. Further, unlike fourth-year students, the learning communities of the third-year students rotate through their clerkship year on the same schedule [8]. The medical students receive no pay or credit for

their mentorship, yet to date far more volunteer than are needed to support the program. This facilitates the process of scheduling the Clinical Scholars with a selection of clerkships, and learning communities have been shown to increase retention in engineering programs, particularly among at-risk groups [9].

The immersion experiences

Before their summer clerkships begin, the academic deans of the school of medicine call for volunteer mentors from among the 3rd year students. Clinical Scholars are assigned to those students to best leverage their schedule of clerkships, providing 3-4 clerkships for each Scholar, each of 1-4 week duration. Scholars have a new medical student mentor for each clerkship.

Clinical Scholars join their teams as "observers" rather than as "learners." This is important (a) to not dilute the instructional quality and hands-on time for the medical students, (b) to separate the Clinical Scholar from the patients to ensure patient safety, and (c) to not violate Residency Review Committee rules for maximum team size.

Deliverables

Every Clinical Fellow is required to maintain a detailed design notebook of their clinical experiences and observations, conforming to HIPAA requirements. Two written deliverables are due at the end of each clerkship: at least one clinical problem or unmet clinical need, and at least one clinical case study designed to the needs of preselected BME classes. Writing these reports is excellent training for students in technical writing, itself considered a high-impact practice [7].

Clinical needs reports are designed for use by the design instructors in BME. Each report consists of (a) a problem statement, (b) a background statement, including information with references necessary for a person outside the clinic to fully understand the problem, (c) a brief market analysis, meant to place bounds on the number of people or institutions who have the problem, and (d) a statement of design requirements.

Case studies are designed as either preparatory guides for use by faculty, or as assignments to be given directly to students. Case studies vary in content according to the needs of the specific class for which the case is being developed. However, these cases typically consist of quantitative, analytical, or computational challenges or exercises.

Data, and lessons learned from our first cohort

The inaugural year of five scholars were embedded in a total of 12 unique clerkships, ranging from 1-3 weeks in duration. Urology, Preoperative Medicine, Internal Medicine (GI, ICU), Ophthalmology, OB/GYN, Pediatrics, Emergency Medicine, General Surgery, Neurology, Pediatrics, and Neurosurgery. None of the problems identified by the Scholars were ultimately adopted by Capstone teams, even by the Scholars themselves. We anticipate at least one case study being used by an instructor the semester of this writing.

We surveyed the participants (5) to learn how the immersion experience changed their career aspirations. At the beginning of the program, the Scholars were 88% ± 5 certain of becoming physicians, and 65% ± 8 certain of becoming engineers. Thus, this particular cohort was strongly biased at the beginning of the program toward becoming physicians. At the end of the program, the Scholars were 90% ± 6 certain of becoming physicians (no significant change from the beginning, $p=0.4$), and 81% ± 5 certain of becoming engineers ($p=0.05$). The effect size for

increasing interest in becoming an engineer was large (Cohen's d=1.1). This is most easily described as the program promoting the development of Clinician Engineers.

We also asked participants to estimate the impact of the immersion experience on the *ability* dimension of their *engineering design self-efficacy* – a measure of students' self-perceived ability to engage in nine different engineering tasks [10], to which we added "document technical matters," "learn new things," and "empathize." There were across-the-board gains in every aspect of *ability*, but most so in "Learn new things," "Empathize," "Communicate," and "Document technical matters." Each of these had more than *double* the effect size of the next most affected task – "Identify a need." This is especially interesting because needs identification is not only a primary goal of our program, but also a goal of NIBIB R25 programs in general [11].

To broaden impact

The inaugural year of our program showed where there is room for improvement with second cohort. The first of these improvements, already enacted, is to urge students to apply who do not consider themselves to be pre-med. This did indeed change the spectrum of career intentions in our next cohort. We are also requiring Scholars to choose one of their own identified problems for their Capstone project, and to identify clinician collaborators for every problem they report. We will also be requiring Scholars to more closely with the BME faculty in crafting case studies, and will enact measures to ensure timely completion of deliverables. We are still considering whether any training is needed for the medical student mentors.

Literature cited

[1] J. Ackerman and R. Schaar, "Clinical Observational Design Experience: A Large Design Oriented Clinical Immersion Course Based In Emergency Departments," VentureWell, 2016.

[2] S. Sood, M. Short, R. Hirsh, J. Kadlowec, and T. Merrill, "Biodesign through Clinical Immersion," 2015. [Online]. Available: http://venturewell.org/open/wp-content/uploads/2013/10/SOOD.pdf.

[3] S. J. Miller, R. Doshi, J. C. Milroy, and P. G. Yock, "Early Experiences in Cross-Disciplinary Education in Biomedical Technology Innovation at Stanford University," *J. Eng. Educ.*, vol. 90, no. 4, pp. 585–588, Oct. 2001.

[4] J. Kadlowec, T. Merrill, R. Hirsh, and S. Sood, "Work-In-Progress: Clinical Immersion and Team-Based Engineering Design," 2015, pp. 26.1762.1-26.1762.5.

[5] B. Przestrzelski and J. DesJardins, "The DeFINE Program: A Clinical Immersion for Biomedical Needs Identification," 2015, pp. 26.1514.1-26.1514.16.

[6] K. H. Sienko, E. E. Kaufmann, M. E. Musaazi, A. S. Sarvestani, and S. Obed, "Obstetrics-based clinical immersion of a multinational team of biomedical engineering students in Ghana," *Int. J. Gynecol. Obstet.*, vol. 127, no. 2, pp. 218–220, Nov. 2014.

[7] G. Kuh, "High-Impact Educational Practices," *Association of American Colleges & Universities*, 24-Jun-2014. [Online]. Available: https://www.aacu.org/leap/hips. [Accessed: 24-Feb-2016].

[8] M. Keeley and C. Peterson, "Longitudinal and Multifaceted Support: The Evolution of Learning Communities at the University of Virginia School of Medicine," presented at the AAMC Annual Meeting, 2014, p. Resource ID 3867.

[9] K. G. Ricks, J. A. Richardson, H. P. Stern, R. P. Taylor, and R. A. Taylor, "An Engineering Learning Community To Promote Retention And Graduation Of At-Risk Engineering Students," *Am. J. Eng. Educ. AJEE*, vol. 5, no. 2, p. 73, Nov. 2014.

[10] A. R. Carberry, H.-S. Lee, and M. W. Ohland, "Measuring Engineering Design Self-Efficacy," *J. Eng. Educ.*, vol. 99, no. 1, pp. 71–79, Jan. 2010.

[11] "Team-Based Design in Biomedical Engineering Education (R25)," *National Institute of Biomedical Imaging and Bioengineering*, 07-Apr-2015. [Online]. Available: https://www.nibib.nih.gov/training-careers/undergraduate-graduate/team-based-design-biomedical-engineering-education-r25-0. [Accessed: 04-Feb-2019].