The Importance of Interdisciplinary Research Training and Community Dissemination

Simone V. Gill, Ph.D., O.T.R./L.[1], Misha Vessali[1], Jacob A. Pratt, B.S.[1], Samantha Watts[1], Janey S. Pratt, M.D.[2], Preeti Raghavan, MD.[3], and Jeremy M. DeSilva, Ph.D.[4]

Abstract

Funding agencies and institutions are creating initiatives to encourage interdisciplinary research that can be more easily translated into community initiatives to enhance health. Therefore, the current research environment calls for interdisciplinary education and skills to create sustained partnerships with community institutions. However, formalized opportunities in both of these areas are limited for students embarking on research careers. The purpose of this paper is to underscore the historical and current importance of providing interdisciplinary training and community dissemination for research students. We also suggest an approach to begin to address the existing gap. Specifically, we suggest embedding a 10-week summer rotation into existing research curricula with the goals of: (1) providing students with a hands-on interdisciplinary research experience, (2) facilitating dialogue between research students and community settings to disseminate science to the public, and (3) sparking collaborations among researchers who seek to create a way to sustain summer program rotations with grant funding. Clin Trans Sci 2015; Volume 8: 611–614

Keywords: interdisciplinary, research, education

Although the need for interdisciplinary research appears to be contemporary, its importance is not new.[1] Many researchers whose discoveries are the foundation of the basic sciences were interdisciplinary in a Renaissance sense; they embodied interdisciplinary research by making significant contributions across multiple disciplines. Sir Isaac Newton, physicist and mathematician, was largely responsible for the 17th century scientific revolution and the creation of calculus. Rene Descartes, mathematician and philosopher, invented the Cartesian system and the philosophy of mind–body dualism. Similarly, physician, surgeon, and philosopher Claudius Galen contributed foundational texts on human anatomy and the circulatory system, but espoused the idea that the perfect physician should also be a philosopher.[2] The purposes of this paper are to: (1) underscore the historical and current importance of interdisciplinary training and community dissemination for research students and (2) suggest an approach to address the current gap in interdisciplinary education.

Interdisciplinary Research and Education

Origins

Influential scientists understood the importance of educating future researchers using an interdisciplinary approach. One of the founding fathers of neuroanatomy, Santiago Ramon y Cajal, stressed the need for breadth of knowledge in educating future scientists: “the biologist does not limit his studies to anatomy and physiology, but also grasps the fundamentals of psychology, physics, and chemistry.”[2] Likewise, Pierre–Simon Laplace, mathematician and astronomer, conferred that “to discover is to bring together two ideas that were previously unlinked.”[2] Modern thinkers such as E. O. Wilson,[3] Linus Pauling,[4] and Anne Fausto-Sterling[5] have cultivated scientific schools of thought that emerged from interdisciplinary research. Therefore, the spirit of interdisciplinary research lies at the core of basic science, and particularly its translation to widespread use.[6]

The current need for interdisciplinary education and research

Research trainees currently receive specialized training in a particular discipline and seldom interact with students from other disciplines.[7] Discipline-specific training is critical for ensuring research excellence within fields.[8] However, training that is solely discipline-specific can affect students’ ability to be competitive for successful research careers.[7] In fact, students are encouraged to be specialized early on in their education (i.e., undergraduate school) with course requirements that are very focused.[9] With little exposure to an interdisciplinary educational approach, students may lack the ability to incorporate an interdisciplinary approach later on in their research careers. At some level, interdisciplinary training is occurring. Examples include problem-based learning in medical schools such as the Cleveland Clinic Lerner College of Medicine,[10] interprofessional programs sponsored by the Macy’s Foundation, and Clinical and Translational Science programs. However, these opportunities are still limited. The lack of such training teaches students to treat scientific disciplines as separate entities. Thus, unless students are enrolled in programs that cut across disciplines, they may receive little to no training in conducting interdisciplinary research.

This problem is escalated in graduate education where subspecialization forces students to learn a single discipline in depth and further separates professionals in different disciplines. This often occurs in the field of medicine where surgeons and internists, at times, have trouble communicating about a patient because they are no longer speaking the same language that they learned in medical school. Cross-disciplinary training has decreased because early subspecialization has become the new paradigm in medical training with students going directly into specialties such as cardiothoracic surgery. In the past, these residents were required to train in general surgery prior to specializing. Medicine has changed in that midlevel medical providers and nurses now work alongside physicians more than they did before. However, most of these providers are still highly trained in a specific field. We must be careful in the medical field

[1]Department of Occupational Therapy, Boston University, Boston, Massachusetts, USA; [2]Department of Surgery, Massachusetts General Hospital, Boston, Massachusetts, USA; [3]Rehabilitation Medicine, NYU Langone Medical Center, New York, New York, USA; [4]Anthropology, Boston University, Boston, Massachusetts, USA.

Correspondence: Simone V Gill (simvgill@bu.edu)

DOI: 10.1111/cts.12330

not to lose the great benefits of interdisciplinary training both for clinical effectiveness for patients but also for creating innovative and effective research programs.

Recommended solutions

Incorporating an interdisciplinary component to existing academic-year curricula can be challenging because of already packed schedules. Therefore, we suggest starting the formal aspect of interdisciplinary research education with a structured, ten-week summer program. The first goal of the summer program could be to provide students with a hands-on interdisciplinary research experience paired with interdisciplinary discussions among the students. A team of four or five researchers from two disciplines would lead the program and be available to mentor students. Ideally, this team could consist of two of three pairs of researchers from different disciplines who already collaborate on research projects. At the start of the summer, the team of researchers would each give a 15- to 20-minute talk about their research to the incoming group of summer students. After the talks, students would be asked to select a primary mentor from one discipline and a secondary mentor from a different discipline. Students would then participate in research training in the primary mentor's lab based on a research question formulated with the mentor. The secondary mentor would help students to examine their question from an interdisciplinary perspective via meetings and focused readings. Students would regularly be brought together throughout the summer to discuss their research and to receive insight into overcoming hurdles related to using an interdisciplinary approach. During these meetings, mentors would assist the students in explaining their research to one another in layman's terms. At the end of the summer, students would give 15- to 20-minute talks to the team of researchers and to their fellow students about the findings from their research projects. Below, we present two sample settings (i.e., a medical setting and a university setting) to illustrate examples of interdisciplinary teams.

Setting 1: At Massachusetts General Hospital, the Center for Transplantation Sciences conducts research on immunologic mechanisms to facilitate patients' tolerance to organ transplants. Their work requires researchers from multiple disciplines including medical doctors who specialize in infectious disease, surgeons, and cardiologists as well as PhD-trained researchers who are immunologists to work together. The center consists of multiple labs with a different principal investigator leading each lab. In our suggested summer rotation, in this setting, a student would choose a primary mentor from one lab (e.g., genetic engineering) and a secondary mentor from another lab (e.g., transplantation biology).

Setting 2: At Boston University, PhD-trained researchers from two labs have been examining the relationship between the structure of the foot arch and walking across the lifespan.[11-13] The goal of this research is to understand the association between form (i.e., arch structure) and function (i.e., walking). The researchers are an occupational therapist and a biological anthropologist. The occupational therapist brings expertise in quantifying and rehabilitating human movement and walking in children and adults. The biological anthropologist is an expert in reconstructing the locomotor habits of early humans via an examination of the human foot. Many of the students that these researchers have mentored in their labs are undergraduates who go on to medical school. In our suggested summer rotation, in this setting, a student would choose one of the researchers as a primary mentor and the other as a secondary mentor.

Disseminating Science to the Public

History

Similar to the origins of interdisciplinary research, there is also historical precedence to public science dissemination. The Christmas lectures held at the Royal Institution in London began with a lecture by the scientist Michael Faraday in 1825 to introduce science to young children even before formal science education was provided.[14] Today the lectures are an important forum for scientists to discuss the relevance of their research findings to those outside of the research community. A recent longitudinal study showed that children demonstrated a change in their understanding of the brain after attending a Christmas lecture,[15] speaking to the impact of the Christmas lectures. Exposure to science also occurs via programs designed to disseminate findings to the public such as Neil deGrasse Tyson's Cosmos: A Spacetime Odyssey or the televised moon landing in 1969. A more modern version of the Christmas lectures are the TED talks: a yearly conference series that began in 1990 with the goal of disseminating world-changing ideas of experts to the public.[16] The World Science Festival in New York city, which showcases the work of scientists to the public over a week every spring also demonstrates how this can be accomplished.

Dissemination of science to the public can also serve to further our current research culture where senior research students (e.g., graduate students) often mentor junior research students (e.g., undergraduates) who show interest in pursuing research careers. Senior research students could use public science dissemination as a tool to motivate and recruit young people to science. Introducing research in community forums may be impactful for youth particularly from underrepresented minority groups who often decide prior to graduate school whether to pursue careers in science.[17] This can then serve to increase diversity in science, which can make science even more relevant to solving complex problems of society. Therefore, integrating public science dissemination into research education could have far-reaching effects for the scientific community and for society.

Public science dissemination as a necessity

Two aspects of what is now a difficult funding climate make public science dissemination a necessity.[18] First, the challenge of obtaining federal funding for research has led more scientists to explore funding opportunities from other sources such as community organizations, foundations, corporate sponsors, or philanthropists (e.g., crowd funding). These organizations are often interested in the broader impact of research at the community level making it imperative that scientists communicate the public relevance of their work. Second, funding agencies such as the National Institutes of Health (NIH) have called for health-related research to be translational: from bench to bedside.[19] Collaborating with community organizations increases the potential to conduct translational research by partnering with those whose lives researchers hope to improve. In particular, community organizations may provide access to relevant consumer groups. Public science dissemination can also positively influence policy. It is critical to educate the public and policymakers about the important contributions of science to society to ensure that funds are dedicated for scientific research and education. However, few students of science are instructed on how to communicate their findings effectively to the public.[20]

Recommended solutions

A second component to the proposed 10-week summer program would facilitate dialogue between research students and community settings to foster better communication between scientists and nonscientists and enhance the relevance of scientific work to everyday life. In addition to choosing a primary and a secondary research mentor, at the start of the summer, students would also be asked to choose a community organization to which their scientific work would be relevant. For this component, the students would need to build partnerships with their selected organization and write a "TED-style" talk on their research to present to the community organization. The talk could be a lay person's version of the talk that they would present to the mentoring team at the end of the summer.

Setting 1: Within a medical setting, students could partner with hospital communications managers who sponsor community events for patients (e.g., community health forums) or with local community organizations who would be open to sponsoring a forum for community members (e.g., local YMCA).

Setting 2: PhD-trained researchers can partner with one or more community organizations relevant to their work. For example, the researchers in Setting 2 from the first example, partnered with the Museum of Science in Boston where both the researchers and their students had informal opportunities to disseminate science to the public. The suggested 10-week summer program would allow for a formalized presentation format to the public.

Institutional Mechanisms for Interdisciplinary Research

Federal and educational

Interdisciplinary research is clearly an important aspect of our current research environment. Two major US funding agencies, the NIH and the National Science Foundation (NSF), have mechanisms that encourage interdisciplinary collaborative research among scientists.

Educational institutions have also created mechanisms to encourage interdisciplinary research within universities. Major universities offer grants to facilitate interdisciplinary research collaborations. These internal grant mechanisms aim to bring together researchers from multiple disciplines that will lead to large working groups.

It is this climate that students of science will enter after leaving doctoral programs and postdoctoral fellowships. Yet, limited opportunities exist for research students to obtain formalized training in establishing sustainable interdisciplinary research programs that are the basis of the new grant mechanisms available.

Contribution of grant funding rates

Traditionally, research students have been trained to establish large, individual research programs that they pursue over the majority of their careers. Such research programs require high-levels of funding to be operational: to have a thriving laboratory with state-of-the-art equipment and well-trained staff. However, falling funding rates threaten the sustainability of large, individual research programs. At the NIH, overall funding rates for individual researcher grants (i.e., R01s) have dropped by 10% from 27.6% of applicants receiving funding in 2005[21] to 17.5% of the applicants being funded in 2013.[22] Last year alone, over 60% of the NSF Social, Behavioral, & Economic Sciences budget has been cut from $256 to $150 million.[23] Therefore, it is advantageous for talented researchers from multiple disciplines to pool their resources by working collectively. It is even more critical for future researchers to be engaged in this process from the very beginning of their training. Hence, providing interdisciplinary training for research scientists is central to the sustainability of science.

Recommended solutions

To be practical and sustainable, the proposed interdisciplinary summer program would require funding from federal or institutional resources. From the federal perspective, both NIH and NSF advertise program announcements (e.g., BIRT: Building Interdisciplinary Research Team Revision Awards) or solicitations (e.g., INSPIRE: Integrated NSF Support Promoting Interdisciplinary Research and Education) for interdisciplinary research. Examples of internal grant mechanisms at universities include Harvard (e.g., Harvard Catalyst Grant), Boston University (e.g., Coulter Translational Partnership), and Stanford (e.g., Interdisciplinary Research Award). Grants sponsored by the Patient-Centered Outcomes Research Institute, which mandate stakeholder involvement, could also be used to link researchers with consumer groups and organizations. The research mentoring team that we propose to lead the 10-week summer program could target grant solicitations to: (1) provide summer funding for the student program (e.g., stipends for students, summer salary for researchers on 9-month appointments) and (2) initiate long-term relationships with community organizations.

Limitations

We acknowledge several limitations. First, we recognize that the suggested program cannot entirely fill the gap in interdisciplinary training. Therefore, future directions may require partnering with organizations that could support the suggested program on a national scale (e.g., the Association of American Physiatrists who sponsors the Rehabilitation Research Experience for Medical Students program). Second, there are practical barriers to interdisciplinary collaboration that may not be addressed by an interdisciplinary summer research program. For example, competitive funding environments, authorship standards, and promotion criteria at times may not recognize the equal intellectual contributions of multiple investigators.

Conclusion

We suggest a practical approach to educating future researchers about performing interdisciplinary research and creating partnerships with community organizations. We not minimize the importance of excellence within disciplines nor the difficulties inherent in creating interdisciplinary collaborations.[24] However, training students to incorporate interdisciplinary thinking into their research repertoires is important for creating sustainable solutions for the future of science.

Acknowledgments

The authors wish to thank the Motor Development Laboratory for reading earlier versions of this manuscript.

Source of Funding

This work was supported in part by an NIH grant K12HD055931 to Simone V. Gill.

References

1. Youmans JB. Interdisciplinary collaboration in medical education and total patient care: new approaches to education for the practice of medicine in modern society. *J Psychiatr Social Work*. 1953; 23(1): 11–18.

2. Ramon y Cajal S. Advice for a Young Investigator. Cambridge, MA: MIT Press; 1999.

3. Wilson EO. The sociogenesis of insect colonies. *Science*. 1985; 228(4707): 1489–1495.

4. Pavao AC, Taft CA, CGuimaraes TCF, Leao MBC, Mohallem JR, Lester WA Jr. Interdisciplinary applications of Pauling's metallic orbital and unsynchronized resonance to problems of modern physical chemistry: conductivity, magnetism, molecular stability, superconductivity, catalysis, photoconductivity, and chemical reactions. *J Phys Chem.* 2001; 105(1): 5–11.

5. Fausto-Sterling A. Science: the broader context. *Science*. 1996; 273(5279): 1157–1158.

6. Klein JT. Interdisciplinarity: History, Theory, and Practice. Detroit: Wayne State University Press; 1990.

7. Tekian A. Doctoral programs in health professions education. *Med Teacher*. 2014; 36(1): 73–81.

8. Metzger N, Zare RN. Interdisciplinary research: from belief to reality. *Science*. 1999; 283: 642–643.

9. Nelson-Hurwitz DC, Tagorda M. Developing an undergraduate applied learning experience. *Front Public Health*. 2015; 3: 2–10.

10. Sandhu JS, Hosang RN, Madsen KA. Solutions that stick: activating cross-disciplinary collaboration in a graduate-level public health innovations course at the university of california, berkeley. *Am J Publ Health*. 2015; 105(Suppl 1): S73–S77.

11. DeSilva JM, Gill SV. Brief communication: a midtarsal (midfoot) break in the human foot. *Am J Phys Anthropol*. 2013; 151(3): 495–499.

12. DeSilva JM, Bonne-Annee R, Swanson Z, Gill CM, Sobel M, Uy J, Gill SV. Midtarsal break variation in modern humans: functional causes, skeletal correlates, and paleontological implications. *Am J Phys Anthropol*. 2015; 156(4): 543–552.

13. Gill SV, Lewis CL, DeSilva JM. Arch height mediation of obesity-related walking in adults: contributors to physical activity limitations. *BioMed Res Int*. 2014; 2014: 1–8.

14. Berman M. Social Change and Scientific Organization: The Royal Institution 1799–1844. Ithaca, NY: Cornell University Publishing; 1978.

15. Gjersoe NL, Hood B. Changing children's understanding of the brain: a longitudinal study of the Royal Institution Christmas Lectures as a measure of public engagement. *PloS One*. 2013; 8(11): e80928.

16. Masson M. Benefits of TED talks. *Canad Family Phys Med Famille Canad*. 2014; 60(12): 1080.

17. NIH. Draft report of the advisory committee to the director working group on diversity in the biomedical research workforce: NIH; 2012.

18. Miller AL, Krusky AM, Franzen S, Cochran S, Zimmerman MA. Partnering to translate evidence-based programs to community settings: bridging the gap between research and practice. *Health Prom Pract*. 2012; 13(4): 559–566.

19. Balneaves LG, Lee RT, Guns ES, Zick SM, Bauer-Wu S, Greenlee H. Tenth International Conference of the Society for Integrative Oncology Translational Science in Integrative Oncology: from bedside to bench to best practices. *Integr Can Therap*. 2014; 13(1): 5–11.

20. Begg MD, Crumley G, Fair AM, Martina CA, McCormack WT, Merchant C, Patino-Sutton CM, Umans JG. Approaches to preparing young scholars for careers in interdisciplinary team science. *J Investig Med*. 2014; 62(1): 14–25.

21. Bravo NR. Increasing R01 competition concerns researchers. *J Nat Cancer Inst.* 2006; 98: 1436–1438.

22. Rockey S. FY.2013 by the numbers: research applications, funding, and awards. 2013; http://nexus.od.nih.gov/all/2014/01/10/fy2013-by-the-numbers/. Accessed May 20, 2014, 2014.

23. Morrison J. Incoming NSF director faces challenges in Congress. *Nature*. 2014; 507: 285.

24. Repko AF. Interdisciplinary Research: Process and Theory. Los Angeles: Sage Publications, Inc.; 2008.