“Jack of All Trades and Master of One:” Training for Interdisciplinary Research

John C Ford*

Department of Chemistry, Indiana University of Pennsylvania, Indiana, USA

This journal, at least with this title, would not have existed fifty years ago. Bioanalytical chemistry, as a named discipline, did not really exist fifty years ago. Although the first use of that term in the American Chemical Society journals was in 1962 [1], it was only in 2002 that the venerable Fresenius’ Journal of Analytical Chemistry was renamed to Analytical and Bioanalytical Chemistry [2]. The 2004 text by Susan R. Mikkelsen and Eduardo Cortón seems to be the first by that name [3]. The Ralph N. Adams Institute for Bioanalytical Chemistry at the University of Kansas was dedicated in 2006, the same year that The Institute of Bioanalytical Chemistry was established at The University of Leipzig [4,5]. The European Bioanalysis Forum was also established that year [6]. As young as it is, bioanalytical chemistry may represent one of, if not the, first interdisciplinary fields. It foreshadowed the course of modern science.

Epigenomics, metamaterials, systems biology, photonics, chemical ecology, molecular epidemiology, and bioinformatics are all areas of active exploration largely nonexistent a decade ago. And each such area (and numerous others) potentially offers significant benefits to society, as well as poses significant analytical problems. The questions involved transcend traditional disciplinary boundaries; we are tackling bigger problems, exploring greater levels of complexity than ever before. The age of “Big Science” is upon us.

Arguably, the biological sciences and medicine have experienced the development of cross-disciplinary and interdisciplinary research to a greater extent than other disciplines of science and engineering. This is reflected in the number of scholarly reports concerning the impact this development has had in the biological sciences, particularly in biomedical research. The future of interdisciplinary research and training was discussed by Goodman and Blake [7], who described the growth of the Institute of Biomedical Sciences and Technology (IBMST). In 2003, the IBMST was “created to stimulate the formation of teams of scientists with different backgrounds and expertise” with over 100 participating faculty only three years later [7]. These authors even declare, “Many important questions can only be answered by research teams consisting of scientists of multidisciplinary background who combine expertise in the biological, physical, engineering, and computer sciences”. Chang et al. specifically address approaches to adapt postdoctoral training in the health sciences [8], while Humphrey et al. focus on graduate education in the biomedical sciences and engineering [9]. Welsh et al. review not only the importance of training in impacting interdisciplinary research but also the importance of infrastructure and even of reward systems [10]. The critical importance of collaboration is recognized in all these reports, and is the explicit focus of Hall et al. [11].

Training scientists to participate effectively in collaborative, broad research projects is increasingly recognized as an unresolved and largely unexplored factor in the advancement of modern science. The general consensus seems to be that preparing a new generation of scientists to take part in the collaborative projects of the future requires training in a wider range of traditional subjects [8-10]. Labov et al. [12] described the new researcher in quantitative biology as a “scientist with a deep knowledge in one discipline and a working fluency in several others”.

It is generally accepted that the best way to train scientists to do science is by doing science. Undergraduate research is a requirement for programmatic certification by the American Chemical Society [13]. I have personally witnessed the excitement engendered by engagement with a research project, even among students who find traditional laboratory exercises tedious and boring. Providing suitable research experiences for undergraduates can be difficult, but is considered a professional obligation and given very high priority by most faculty I know, especially those at primarily undergraduate institutions. However, insofar as I know, very few undergraduate institutions foster significant interdisciplinary experiences for undergraduates. This may be no accident. In my experience, undergraduates tend to prefer well-defined, comprehensible learning experiences, even when it comes to research experiences.

Thus, I was not surprised that Knisley and Behravesh found that their ambitious attempt to foster collaborations between senior undergraduate mathematics majors at East Tennessee State University (ETSU) and junior-level engineering students in the Biomedical Engineering Problem-Based Learning laboratory at Georgia Institute of Technology-Emory Biomedical Engineering program (BME) was met with mixed response [14]. The students worked together to explore the question of why female athletes are 4-6 times more likely to suffer ACL injuries than male athletes. The ETSU students were required to create models that could be tested experimentally by the BME students. Although 42% of the BME students involved considered the experience “below average,” the authors indicate that the students’ outcomes may actually provide some predictive insight into the origin of the ACL injury differences. Given that this curricular exercise was approximately one fifth of one semester, I personally am amazed at the success of their exploratory project.

Training scientists to participate in large-scale, collaborative research is going to require such interdisciplinary, collaborative learning experiences. The ETSU-BME experience may not have been viewed overwhelmingly favorably by the students, but I think it points the way to the future of education in science or technology. Faculties at smaller institutions are going to have to develop curricular collaborations to provide the kind of educational experiences necessary. This may pose some logistic problems, but also some opportunities: for example,

*Corresponding author: John C Ford, Associate Professor, Department of Chemistry, Indiana University of Pennsylvania, Indiana, PA 15705, USA; Tel: 412-357-5702; E-mail: jford@iup.edu

Received October 27, 2012; Accepted October 27, 2012; Published November 02, 2012


Copyright: © 2012 Ford JC. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.
I can envision organizations developing specifically to foster such educational collaborations.

These are exciting times in science. Our ability to manipulate matter in controlled fashions is greater than ever. We can sequence whole genomes in times unimaginable only a decade ago, at a cost a mere fraction of the cost of sequencing the human genome. We are performing geochemical analyses on another planet and while it is not the first time, we are doing it with a wider variety of far superior tools. We can model systems which would have been considered impossibly complex only twenty years ago. We are tackling ever-bigger problems, demanding the expertise of a variety of disciplines and effective collaborations using electronic tools. And we need to adapt our educational systems to foster such abilities, without sacrificing fundamental understanding. So these are exciting times in education as well.

References

5. Institute for Bioanalytical Chemistry.