



Contents lists available at ScienceDirect

acta histochemica

journal homepage: www.elsevier.de/acthis

Editorial

Improving Science Education Worldwide

Steven Oppenheimer, Editor of *Acta histochemica*, was awarded a 2009 U.S. Presidential Award based on the work presented in his Essay on Improving Science Education Worldwide after selection by the National Science Foundation and the White House. The presentation of the award by President Obama was made in the Blue Room of the White House on 6 January 2010 and we are proud to be able to publish his essay, which should provide encouragement and inspiration for research scientists in improving science education, in particular with less privileged youth.

Raymond Coleman, Editor-in-Chief, *Acta histochemica*

Improving Science Education Worldwide

Three of many problems are at the root cause of weak science education worldwide:

- (1) the lack of quality research training of K-12 teachers
- (2) the lack of quality research experiences for K-12 students
- (3) the lack of quality research experiences for university undergraduates.

There is one body of professionals who could help solve these problems: the research scientists, however, research scientists and for that matter most science professors are not rewarded for engaging K-12 teachers or their own undergraduates in research. They are rewarded for publications and training graduate students and postdocs, who produce their publications. They often do not want to be slowed down by K-12 teachers, pre-teachers or undergraduates. The rewards system must be modified if we want to produce great scientists. Universities and industry must reward their personnel for nurturing future generations of scientists.

Here is what I have contributed to helping to alleviate this problem. It could become a model for others to emulate. The Presidential Award recognition is helping to disseminate these approaches worldwide.

As a professor at a large, primarily undergraduate, Hispanic serving public university (about 35,000 students), I found that most of our 1300 biology majors clamor for research experiences, but the large number of students far exceeds the number of faculty available to mentor them. As a result many students who did not have top grades were denied the opportunity of becoming engaged in research as undergraduates. I developed a program to help mitigate this problem that led to about 26 awards and honors from local, statewide and national organizations, including a 2009 U.S. Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. Since this program has been operational, I have never had to turn down any qualified

student interested in trying her or his hand at research. I believe if this sort of program were to be widely implemented nationwide, it would help provide enough research experiences for all students wishing to give it a go.

My program allows me to mentor about 100 undergraduates and 20 Masters students per year. It is based on the simple concept of assembling a group of about 20 advanced research students, providing them with course credit, who help supervise the 100 undergraduates. This yields a ratio of 1 leader to 5 students. In addition, my office is in the lab, allowing me to oversee the whole operation. I actually look at all the student notebooks each day to double-check that they are doing things right. Interestingly enough, usually there are no more than 10 students doing research at one time because of the varying student schedules. The lab is open for business days, nights, weekends, holidays, summers and inter-sessions. The latter two times are very popular because the students can do their research in peace, without the enormous class loads that they have during the academic year.

Other than the unusual numbers of students handled by this research program, the program includes structured literature review and group meetings, where research is discussed and the concepts are explained. Experiments are designed to use inexpensive supplies and one would be surprised at the enthusiasm on the part of the university and other organizations to help fund the program. At my university, credit for promotions and tenure is indeed given for providing research experiences for university and K-12 students and teachers.

Indicators of program success include about 60 published peer-reviewed papers, about 100 professional presentations and about 100 published abstracts of these presentations. About 700 students co-authored the papers and published abstracts/presentations. Many of my program students were admitted to doctoral programs at institutions including Harvard, Stanford, Johns Hopkins, Cornell, Yale, Berkeley and so on. A more careful review of a sample of program students (130) for whom we had follow-up information, indicated that all of them are currently in science associated careers or are in advanced science programs. 46% of this sample of students were women and under-represented minorities. 23% of the 130 students completed the Ph.D. or are in Ph.D. programs. 53% of these folks are women and under-represented minorities.

The National Science Foundation consistently ranks my university, CalState, Northridge, in the top few out of over 500 similar Masters/non-Ph.D. granting institutions, in the numbers of its graduates who go on to achieve doctoral degrees in the sciences and social sciences. This is no accident. We believe that it is the large numbers of quality research experiences offered that help account for this statistic, though we have no data to support this hypothesis.

Finally a word about what we have been doing at the pre-college level to turn kids on to science. About 12 years ago, I established the Journal of Student Research Abstracts, a Library of



Photo 1. Steve Oppenheimer (seated front row second on left) at the Blue Room in the White House where he received the 2009 U.S. Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. Arden Bement, Director of the National Science Foundation, is standing, extreme left.

Congress listed journal that showcases the research of K-12 students. Because of its success in turning on K-12 kids to research (after training their teachers to do research properly), we have never had to spend one penny on the journal. Currently the university and Van Nuys Airport, Los Angeles World Airports, a great friend of science education, fund the journal to the tune of \$17,000–\$30,000 per year. About 500 K-12 students publish their reviewed research in this journal each year and testimonials from parents and teachers suggest that when students at such an early level of education see their work in print, it does wonders for their enthusiasm about science. An analysis of a recent issue suggested that 221 of the 555 student authors were Latinos.

We trained hundreds of K-12 teachers in our research labs over an approximately 25 year period. These are the teachers who implement student research projects in their classes that are published in the journal. Teacher motivation was the essential ingredient to program success. Perhaps the greatest motivator for the K-12 teachers to excite their classes about research was the involvement of the late Nobel laureate Francis Crick. Photo 1

I was flabbergasted when he accepted my invitation to serve as Honorary Chair of our K-12 programs. He visited just about every year for approximately 10 years, presenting and discussing research with the teachers and their students, having photos taken with each and every teacher (a process that took about 3 h), and signing copies of his books for all the teachers. To this day, many of the teachers who excite their students to do research, say that working with Dr. Crick was the greatest motivator for them in their professional careers. They blow up the photos of Dr. Crick shaking their hands as posters for all to see. Many of my colleagues at more prestigious schools asked, “Steve, how do you get Dr. Crick to visit you, while he never accepts our

invitations?” I still cannot answer that, but it was possibly because he felt that K-12 education was so important to the nation, and he did say that my enthusiasm and the grand style in which I did things kept him coming to participate in my programs. Little “big” extras like extraordinary motivational approaches make all the difference in the world.

I believe that if the programs I described here are replicated widely, the future strength of the science workforce would be substantially enhanced. It is up to universities to provide incentives for their professors to engage many more students and teachers in quality research experiences.

Over a 38-year period, the following have provided support for Dr. Oppenheimer's programs mentioned here leading to 24 national, statewide and local awards and honors including the U.S. Presidential Award and Election as Fellow AAAS: NIH (NIGMS SCORE, MARC, RISE, NCI, NICHD), NSF, NASA, Joseph Drown Foundation, ACS, Thomas Eckstrom Trust, California Postsecondary Education Commission, Howard Hughes Medical Institute, Urban Community Services, California Science Project, Los Angeles World Airports (Van Nuys), CSUN Learning-Centered University, Biology Department and College of Science and Mathematics.

Steve Oppenheimer*
Center for Cancer and Developmental Biology, California State
University, Northridge, 18111 Nordhoff Street Northridge,
CA 91330-8303, USA
E-mail address: steven.oppenheimer@csun.edu

*Tel.: +1 818 677 3336.