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Applied Science Research for All Part 2 College Level

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Abstract: This paper is for applied research scientists and any scientists who train students to do research. It consists of two parts: (1) an open door hands-on research training program that helped garner a US Presidential Award for Mentoring and election as Fellow, American Association for the Advancement of Science (AAAS); (2) a Covid-19 Pandemic virtual research training program that provides readings and You Tubes for the students followed by an opportunity to develop new research ideas. The co-authors of this paper are the students who pioneered the virtual program. In the hands-on program of 263 students who reported their career outcomes to Steve, 52 achieved doctoral degrees and became professors and researchers, 62 became M. D.s or M. D.-Ph. D.s, 33 became dentists, 17 pharmacists, 97 became scientists in research and/or education and 2 became lawyers. Many of the students co-authored lab published papers, abstracts and national poster presentations. The program's success resulted from an open door policy that invited all interested students to try their hands at research, regardless of their grade point averages, and organizational components that recruited advanced students to help train new students. Universities and other organizations often look favorably on student mentoring in tenure and promotion decisions. Many students can possibly result in more good publications. Readers can determine, by examining the student co-authored papers in the reference section of this paper, if this expanded student-involved program leads to "good publications," as AAAS and the NSF/White House review committee suggested it did.

Keywords: College Student Research Training, Applied Research Scientists, Covid-19 Virtual Research Program

1. Introduction

Increasing the number of students in research training programs will help keep applied science research alive and well. This should begin at the pre-college level before students' career choices have been decided [1, 2]. At the college level increasing the number of student research trainees can result in more and better research and possibly benefits to tenure and promotion because student mentoring is often favorably looked upon by university and organizational administrators. Here two programs will be showcased that have trained hundreds of research students, leading to many publications and national presentations in well known journals and distinguished career outcomes of the program alumni.

The National Science Foundation/White House evaluation panel reviewing Steve Oppenheimer for a US Presidential Award for research Mentoring said of Steve: "Putting into practice his belief that laboratory research experiences should be available to all interested students, he has developed an open door model that encourages students of all economic strata and ethnic groups to participate in his research. His record has proven true his often-stated expectation that any interested student can succeed in scientific research and can go far into the professional career ranks of science, including the Ph. D. and M. D." The US Presidential Award (PAESMEM) is the highest national mentoring award.

The American Association for the Advancement of Science (AAAS) elected Steve as a Fellow based on his glycobiology research and work with students. A Fellow of the AAAS is defined as "a Member whose efforts on behalf of the advancement of science or its applications are scientifically or socially distinguished."

This paper will describe this research training model and also will describe a virtual research training model that was developed as a result of the Covid-19 Pandemic.

2. Experimental Procedure

Data on numbers of students served, career outcomes of these students, and numbers and types of peer reviewed publications resulting will be provided to document an open door policy for student research training that has garnered well documented success and national recognition. Specific data on numbers of student-coauthored peer-reviewed papers, numbers of students on these papers and average number of students on each paper are included. Specific career outcomes of some lab students who achieved Ph.D. degrees, M.D. and M.D-Ph.D. degrees, dentist degrees, pharmacy degrees, and those who became scientists and lawyers are included. Data on the Covid-19 virtual research training program, including readings and YouTubes and new research ideas developed will be described.

3. Results and Discussion

For those who ask, how can a single professor train so many research students? The answer is simple. Recruit more advanced students to help train the new students.

Another question: Can the quality of the research publications be as good as those from much smaller labs?

The open door student research training program resulted in many peer reviewed papers in well known journals such as Science, Nature, Experimental Cell Research, Zygote, Acta Histochemica, Biochemica Biophysica Acta, American Journal of Applied Scientific Research. These papers can be found in the reference section and viewed by all readers who can decide if they are "good" [3-90]. These papers are intended to give the reader a complete analysis of the publication history of this large, student-involved program, so they can evaluate if large numbers of students produce good papers. [Table 1]. AAAS suggested that they do.

Some mostly student-coauthored papers of note include the American Journal of Applied Scientific Research papers on cell unclumping [23, 24], and assays and the role of sugars in the sea urchin embryo model [5, 6, 10-12, 16, 19, 20-22, 25, 30, 31, 42, 50]. Two papers in Nature and Science on mobility of cell surface receptors in embryonic cells [79, 81] are of special interest. A review on glycobiology that garnered about 10,000 downloads might be the most widely read paper of all…and it was mostly written by a student [7]. A paper on analysis of surfaces of fixed vs live cells [46] was the basis of our use of fixed cells in several experiments [23, 24]. Identification of hyalin as a cell adhesion molecule was the subject of several papers [10-12, 16, 19]. A new way of producing coat-free embryos was of interest to many investigators [55]. The role of specific carbohydrates in development gave this lab major recognition [5, 6, 9, 21, 25]. A microdissection method for isolating the interacting system from sea urchin embryos was perhaps our most elegant piece of work [40]. We developed several assays for use in specific analyses [5, 16, 30, 37, 44, 46]. The role of L-glutamine and glutamine synthetase in cellular interactions was of major and widespread interest [72, 80, 85, 89]. Many papers on cancer cell systems were also produced and often co-authored by students [4, 13, 39, 41, 34, 66, 71, 76-77, 87-89]. Many of these papers fit into more than one listed category; so duplications of some citations will be found.

Table 1. *Data on student co-authors on full length peer- reviewed papers*

Number of student co-authored papers	60
Number of student co-authors	208
Average number of students on these papers	3.5

In addition to the approximately 60 student co-authored peer reviewed full length papers cited here, many student co-authored published abstracts and national poster papers, were completed, often including more than 10 students on each. We try to do this annually, as published abstracts and presentations are great for student resumes and help inspire students, just as do the full length papers. Steve selects the best student work from his research courses to justify some co-authorships. Hundreds of student co-authors appear on these published abstracts. We try to maintain high quality in

the abstracts and posters as in the full length papers with plenty of statistical analyses. Recognizing students for good work is an important component of these nationally recognized programs (AAAS, NSF/White House committee). Data from student evaluations suggest that boundless energy, enthusiasm, clarity and organization keep students excited and engaged and help them succeed [89].

Of 263 alumni of the hands-on research program, 52 achieved doctoral degrees and became professors and researchers, 62 became M. D.s or M. D.-Ph. D.s, 33 became dentists, 17 pharmacists, 97 became scientists in research and/or education, and 2 became lawyers (Table 2). The fact that many of these students did hands-on research cited in the publications listing gave them an immersion in mostly applied research that often carried over to their professional careers. Many applied scientists are in institutions much smaller than the one described here. So it would be impossible to greatly expand student involvement in their research programs. But some expansion is possible just about anywhere.

Table 2. *Career outcomes of some lab alumni.*

Ph.D.s	52
M.D./M.D. Ph.D.s	62
Dentists	33
Pharmacists	17
Scientists	97
Lawyers	2

The Covid-19 Virtual Research Training Program. As a result of the Covid-19 Pandemic, the hands-on research program just described has temporarily morphed into a virtual program. The virtual program consists of students reading and viewing interesting research papers and YouTubes and then developing their own ideas about possible new research. The readings and viewings for the virtual research program include:

Three Gene Editing YouTubes.

One Glycobiology YouTube.

Many selections from the Oppenheimer lab full length papers cited here.

Every second week each student emails Dr. Oppenheimer a written summary of one of the reading or viewing selections.

After 7 such summaries are completed, each student emails Dr. Oppenheimer a new research idea based on her/his readings and viewings.

A few of the student developed ideas follow.

How does Covid-19 affect sperm motility? (Background ref [3].

Nelli Stepanyan Dr. Oppenheimer 495D 28 October 2020. Affects of COVID-19 on Sperm Motility. After volunteering at an OB/GYN office and shadowing IVF (In Vitro Fertilization) and IUI (Intrauterine Insemination) procedures, some wondered if COVID 19 has an affect on infertility. According to "It is currently unknown whether SARS-CoV-19 is viable in semen or whether COVID-19 damages spermatozoa" by Perry and colleagues [Andrology. 2020; 00: 1–3. https://doi.org/10.1111/andr.12831] there could be a possibility that COVID-19 may affect fertility. Upon shadowing IVF and IUI procedures at the clinic, I wondered if COVID-19 infected sperm samples would damage spermatocytes. This experiment will give us more evidence and insight on whether COVID-19 is having an affect on sperm quality and infertility. INTRODUCTION. In this experimental idea, we would take sperm samples from healthy individuals and samples from individuals who are infected by COVID-19. Once we obtain the samples, we would then add albumin, which is a protein wash media that is used to maintain sperm quality during in vitro wash preparation and outside of the incubator. Then we would check for spermatocytes and see if they survive in albumin after putting them in a centrifuge. MATERIALS. The materials used for the experiment are going to include, sperm sample from healthy and infected individuals. Additionally, we will use a centrifuge, centrifuge tube, a compound microscope, microscope slide, albumin, and distilled water. For IUI procedure we would need a sterile cup and pipette. When obtaining a healthy sperm sample we have to make sure that the sperm sample has normal morphology and motile sperm. When preparing the samples we have to make sure that we are maintaining a pH level of 7.2-7.4 and that we are also maintaining cellular homeostasis. The reason we need a close physiological pH value is due to the fact that IUI will be performed on the healthy and infected sperm samples afterward. EXPERIMENT. We will begin the experiment by adding 5mg/ml albumin to at least one million motile spermatozoa and add 10mg/ml of albumin again to at least one million motile spermatozoa. The reason for adding 10mg/ml of albumin is because when we do IUI to check the sperm, we want to increase the survival of healthy spermatocytes. The 10mg/ml albumin for infected cells is used in hopes of maximizing sperm survival and increase in sperm quality. The healthy motile sperm sample with albumin will also serve as our control due to the fact that we know that the sperm are healthy and have higher chances for fertilization. After we prepare our sperm sample with sperm-washing media in a tube we take each and put it in a centrifuge for spinning. We will use another tube filled with 10ml of distilled water in order to balance the centrifuge in order to get the sample well stirred. We leave the media sample in the centrifuge for 10min. If there is still debris we put the sample back for another 10-15 minutes. DATA ANALYSIS: After 10 minutes of spinning for each sample media we will get a smear sample and observe it under a compound microscope. We then check the sample and account for the motility of sperm cells. If sperm are motile and there is no debris we can go ahead and proceed with an IUI. If we see that the samples with infected sperm have no motility we again then take another sample mix with albumin and repeat the process to see if we get a sample with higher motility. After 2-4 sample observations within couple of days, if we don't see healthy motile sperm, we declare the sample not viable for IUI. After declaring our sample not viable, we can send the sample for IVF, get a sperm count and do

everything in vitro. In this way we can get details on our spermatozoa samples and conclude whether COVID-19 has some sort of affect on spermatozoa.

Many ideas on using gene editing for future medical purposes and food improvements. [background viewing, gene editing YouTubes: https://www.youtube.com/watch?v=4YKFw2KZA5o; https://www.youtube.com/watch?v=UKbrwPL3wXE; https://www.youtube.com/watch?v=Ft-160cAx38.

Approaches to reduce cancer cell clumps. Background reference [4].

4. Conclusions

Scientists might use the models presented here to expand their research programs to include more students, so that applied research continues to be alive and well. Recruiting advanced student leaders to help train new students is one mechanism that can help expand the numbers of students served. Co-authorships on laboratory publications and presentations effectively inspire students to continue in applied science research. Boundless energy, enthusiasm, clarity and organization are key components in an effective research training program. Research opportunities should be made available to all interested students, not just those with high GPA's. As stated by NSF/White House Presidential Award evaluation committee, such a program can result in many students going far in science careers, including achieving the Ph. D. and M. D. degrees, documented in Dr. Oppenheimer's data on student career outcomes. The Covid-19 Pandemic provided an opportunity to develop a virtual research training program that offers readings and viewings, leading to the development of new research ideas. The readers can review the references cited here on Oppenheimer lab full length peer-reviewed papers and decide for themselves if the quality of this large student program is good. AAAS, and the NSF/White House Presidential Award committee suggested that it was.

Acknowledgements

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